POWER PLANT ENGINEERING

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Power for Dairy Products

PEVELY DAIRY CO. USES HEAT, LIGHT, POWER AND REFRIGERATION SUPPLIED BY ITS OWN PLANT

NO FOOD NECESSITY is more perishable or more subject to disease contamination than cow's milk. Scientists, however, have devised processes for preserving milk sweet and usable for several days, at the same time destroying disease germs that may be contaminating the milk. This process, called pasteurizing, is a very carefully conducted heat treatment, which is followed immediately by a reduction in temperature to near the freezing point. Due to the time necessarily lapsing between the drawing of the milk from the cows on the dairy farms and delivery to city consumers, practically all milk used by city people is thus treated.

In St. Louis, Mo., the Pevely Dairy Co. supplies a large percentage of the milk used and in their new plant designed for pasteurizing and bottling milk and making butter and cheese over 6000 gal. of milk are handled daily. Power, heat and refrigeration are the principal requirements for carrying out the processes and these are furnished by the power plant located in a building by itself but connected by tunnel to the factory proper. One of the noticeable features of the power plant building proper is the natural light and airy condition of the engine room which is due to the large windows on three sides fitted with skylight panes; these will be noticed in the illustration.

Steam is generated in two Wickes vertical water tube boilers served by Roney stokers, which are driven by a Westinghouse Standard engine. The rating of each boiler is 250 hp. and the pressure carried is 150 lb. Coal is delivered to the plant by trucks, being weighed, as it arrives at the plant, upon the company's own scales. At present the coal used is southern Illinois screenings which is hand shoveled from trucks to bunker and from bunker to stoker hoppers. Ashes are also

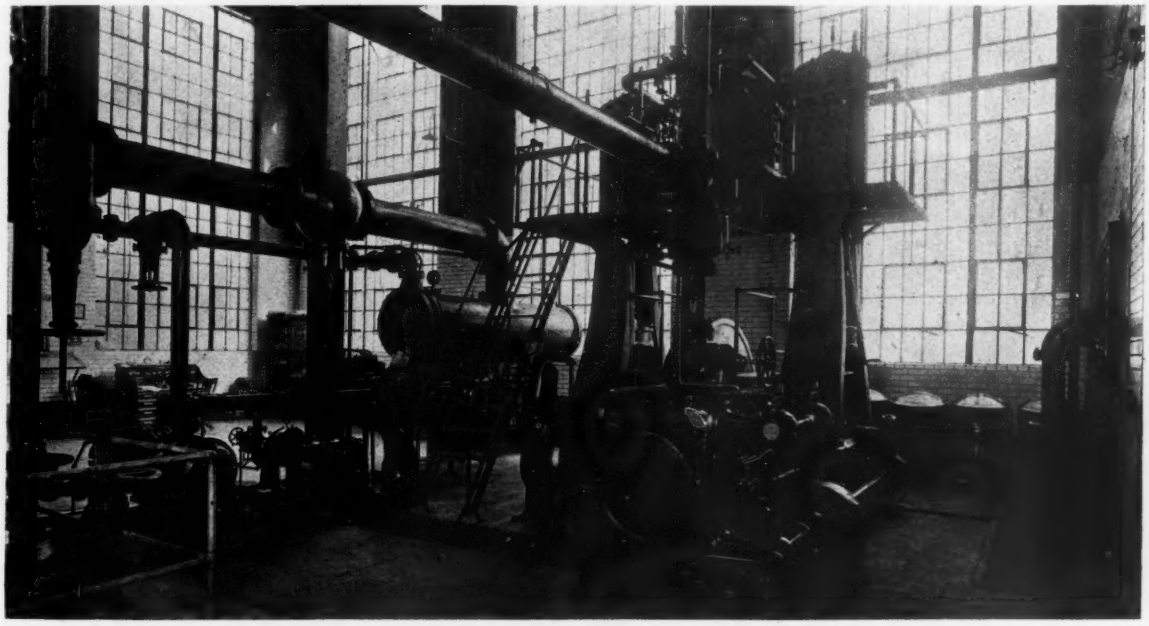


FIG. 3. AMMONIA COMPRESSOR WITH POPPET VALVE ENGINE DRIVE

handled by manual labor from ash pits to wheelbarrow in which they are conveyed to the dump.

All available condensate from the steam condenser is used for boiler feeding, the makeup water being taken from the hot circulating water as it leaves the steam condensers. This water all goes to a 600-hp. Cochrane open feed-water heater from which it is fed to the boilers by two Worthington simplex plunger type 8 by 5 by 12-in. pumps, fitted with stroke counters. The heater is equipped with a bypass and steam cutout, a 16-in. oil separator and a multiport back pressure valve; it takes steam from the auxiliaries. For washing and filling the boilers, the city water pressure is not sufficient, so a small Fairbanks-Morse duplex pump is used. From this, the piping is so arranged that water may be delivered either to the top or lower drum of the boilers. The blowoff piping runs from the center

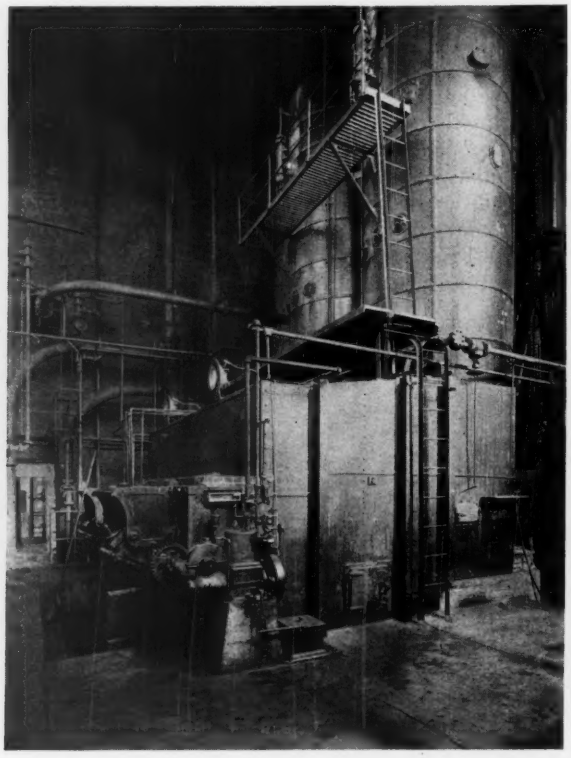


FIG. 1. WICKES BOILERS AND RONEY STOKERS IN THE PEVELY PLANT

of the lower drum head down to a tee, the branch of which carries the discharge through a blowoff cock and Vance blowoff valve to the header leading to the blowoff basin. One outlet of the tee is plugged and opened when it is desired to clean out heavy scale.

The passage of flue gases to the stack is controlled by a Defender damper regulator which operates both dampers in the boiler breechings. The stack is of radial tile with concrete and steel reinforcing, built by the Wiederholdt Construction Co.; it is 150 ft. high and 54 in. in diameter at the top.

One of the interesting features of the boiler room is a cabinet containing a Hoskins pyrometer giving the flue gas temperature which runs about 500 deg., a Defender single chamber Orsat instrument connected up for use which shows average CO_2 in the flue gases to be 12 to 15 per cent, and two Defender duplex draft gages. These instruments together with the practice of weighing coal deliveries and measuring feed water with the pump stroke counters give a reliable check upon the boiler operation. A Defender recording steam pressure gage gives a check on the work of the firemen.

Engine Room Equipment

THE PRINCIPAL refrigerating machine is rated at 100 tons refrigeration in 24 hr. and is run condensing. The ammonia compressor is a standard 16½ by 24-in., 2-cylinder, open frame, single-acting, vertical, York refrigerating machine, driven by a direct connected 20 by 24-in. York poppet valve engine. This engine was designed and built by the York Manufacturing Co., under the Rosenzweig patents, and is the result of an increasing demand for an engine operating under high steam pressures with superheat, which conditions when combined with the proper design of engine given very economical steam consumptions.

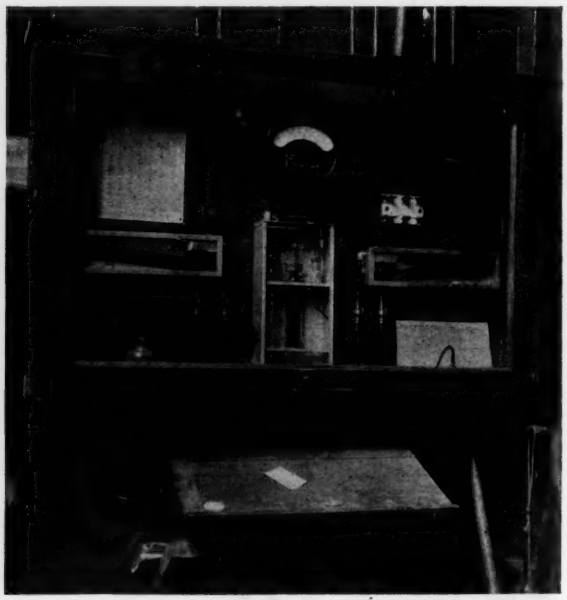


FIG. 2. BOILER ROOM INSTRUMENT CABINET

The valve gear is operated by a lay shaft running alongside the engine driven from the main shaft through a drag crank and shaft, by means of a pair of spiral gears. The drag crank is self-adjustable and prevents unavoidable motion and jars of the main shaft being transferred to the gears which for this reason run perfectly noiselessly and are not subjected to any undue wear.

The lay shaft is placed in line with the exhaust valves, the bonnets of the exhaust valve gear being provided with bearings to support shaft. The exhaust valves are operated by cams acting on anti-friction rollers, effecting a rapid opening and closing. The cams are clamped on the shaft and can be shifted into any position to give the desired release and compression.

This arrangement of lay shaft simplifies greatly the exhaust valve gear as eccentrics, straps, rods and levers are done away with. The steam valves are operated by means of oscillating levers provided with rollers, and curved cam pieces attached to the valve spindles insuring, even at the smallest cutoffs, ample and quick valve openings as well as noiseless operation.

The oscillating levers for both valves are mounted on a single shaft which receives its motion from eccentric rod and eccentric mounted on the lay shaft. It is noteworthy that this arrangement of the valve gear necessitates the use of but one eccentric and strap and rod.

The valves are placed in a horizontal position, well supported by long spindles and guides. The pressure on the guide neglecting the spindle amounts to about ½ lb. per sq. in. The spindles are lubricated by means of force lubrication which passes the oil along the valve spindle through the spiral grooves, on to the guide and then into the steam space, thus obtaining a triple effect besides preventing an escape of steam. The valve spindles are carefully ground into long bushings and provided with a labyrinth packing consisting of small circular grooves.

The effective lubrication and the ample support of the valve spindle effectively prevent any bending stresses in these spindles and preclude absolutely the possibility of wear. The horizontal position of the valves and seats is of distinct advantage as the accumulation of sediment and burnt oil is impossible, the seats being properly cleaned during every steam admission period.

Of particular interest is the design of the valve cages which contain not only valve sets and spindle guide but also the complete structure of the ports. This cage design insures a perfect casting with a reduction in clearance space. The whole valve assembly is easily accessible by simply removing the back covers without interfering with the valve gear. The valve gear parts work in a removable cover, preventing the ingress of dirt, and operate in an oil bath through which the oil may be continuously circulated and used over and over again. Absence of wear, and reliability of operation of the valve gear is insured by this arrangement.

The different load conditions of operation are met with by the use of a compound eccentric operating the steam valves. A small eccentric is keyed to the shaft and a larger one arranged slidable on it, connecting to and controlled by the shaft governor. The large eccentric is so shifted that the combined eccentricities of the two eccentrics become such that practically a constant lead is maintained while the throw increases according to the requirements of the load.

The governor is completely balanced, consists of two pendulums which by means of short arms shift a sleeve mounted on the shaft. The sleeve in turn is connected to and shifts the large eccentric. While the throw of the pendulum is large, the travel of the circular spring of moderate cross section is short producing a governor of best regulating qualities.

A hand speed adjustment is provided which allows change of speed while the engine is in operation. It is possible with this device to increase the speed of an engine by at least 50 per cent.

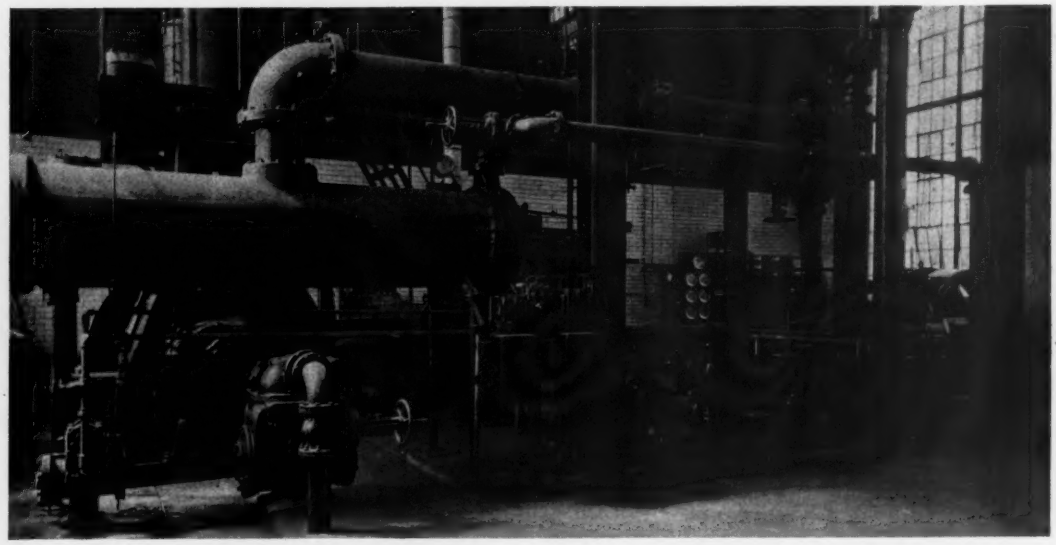


FIG. 4. STEAM CONDENSING EQUIPMENT WITH COMPRESSOR AND GENERATING UNIT IN BACKGROUND

A very effective lubrication is provided for the eccentrics, eccentric strap and governor. The oil is introduced into the hollow lay shaft and forced by centrifugal action to the desired points insuring safe and abundant lubrication.

A metallic packing is provided for the piston rod consisting of cast-iron rings so arranged as to follow the floating action of the piston rod. The packing will effectively prevent the escape of any steam under all conditions of pressure and superheat.

In addition to this unit a 20-ton Frick compressor is installed, this is also of the vertical type, but run by a Corliss engine. The plant is designed to accommodate another unit which will be used for the manufacture of ice.

Electric current for light and power is generated by a General Electric Co. three phase machine driven by a direct connected Ridgway 4-valve engine at 200 r.p.m.

This unit is rated at 160 kw. at 0.8 power factor and supplies alternating current at 240 volts 60 cycles. The exciter is belt driven from the generator shaft and furnishes field current at 125 volts.

The switchboard has four panels for electrical instruments and one for gages. Mounted upon the board are the following instruments: a Tirrill regulator, integrating polyphase wattmeter, d.c. voltmeter, d.c. ammeter, indicating polyphase wattmeter, a.c. ammeter, a.c. voltmeter, service switches, circuit breakers and a two-way switch which is used to throw the load onto the central station circuit at night and during emergencies. Ashton gages are used to indicate the following pressures and vacuums: steam in header, reduced steam on dairy line, steam to pasteurizer, exhaust back pressure, vacuum on compressors, vacuum on heating system, ammonia head pressure and ammonia suction pressure.

Outside current comes to the plant through three service transformers; these reduce the voltage from 2300 to 230. They are of Westinghouse make, rated at 50 kv.a. each and connected in delta across the transmission line. Pole type lightning arresters protect the transformers against surges.

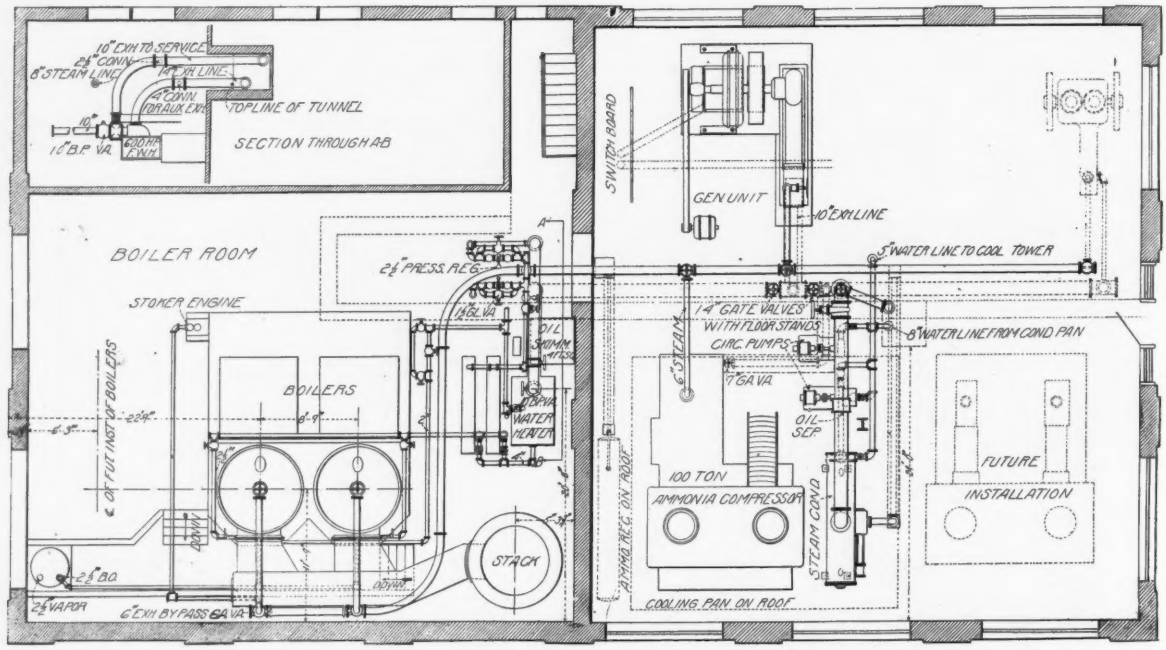


FIG. 5. GENERAL LAYOUT OF EQUIPMENT IN PEVELY PLANT

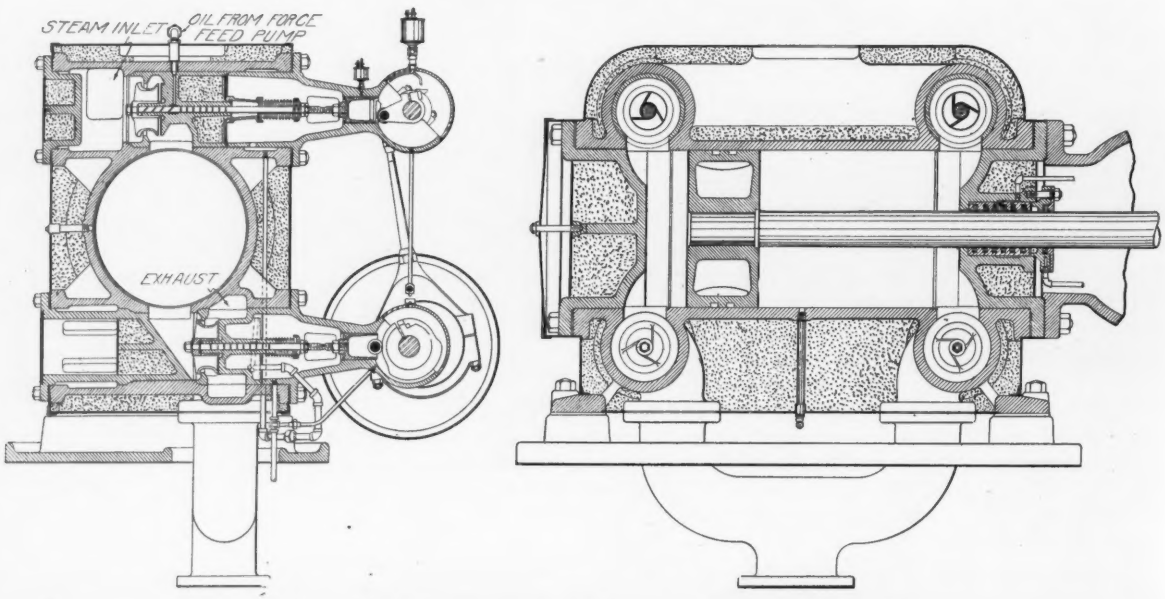


FIG. 6. SECTIONAL VIEWS OF THE POPPET VALVE ENGINE CYLINDER

Condensing System

All of the main steam engines exhaust into a common line leading to an 800-sq. ft. Worthington surface condenser. The Ridgway engine is designed to run either condensing or noncondensing and the exhaust piping is so arranged that the engine may deliver either to the condenser or the heating system. The line to the condenser is provided with a Crane atmospheric relief valve and a Swartwout vacuum oil separator. Condensate and noncondensible gases are taken from the condenser by a Worthington simplex pump, 8 by 14 by 12 in. and delivered to the hot well in the boiler room where the gases separate out and the water is pumped into the heater by a Snow duplex pump.

Cooling water for the steam condenser is taken from the catch pan under the ammonia condenser located on the engine room roof. For forcing this water through the steam condenser and up to the cooling tower, two Worthington motor driven centrifugal pumps are installed; one is a two-stage 3 in., driven by a 15-hp. G.E. motor, the other is single stage 3 in. volute type driven by a 25-hp. motor; the speed of both is 1800 r.p.m.

The cooling tower is located on the roof of the dairy and was built by the Rummeli-Dawley Mfg. Co. for handling 1,000,000 gal. of water in 24 hr. To aid the circulation of air through the tower a 12-ft. fan is located at the base and is driven by a 25-hp. motor. From this point the water has considerable head and flows by gravity over the ammonia condensers.

As previously stated the ammonia condenser is located on the engine room roof; it is of the Shipley atmospheric type consisting of 10 stands 12 pipes high and 20 ft. long. The liquid ammonia drains from these coils to a receiver also on the roof whence it goes to the dairy for cooling purposes.

Connecting the power plant with the main building is a tunnel 6 ft. by 6 ft. in which all piping and cables

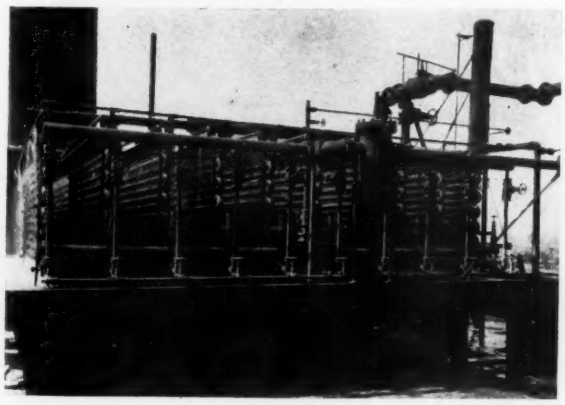


FIG. 7. VIEW OF SHIPLEY AMMONIA CONDENSERS

are run. Steam is furnished at 130 lb. for pumping rinsing water, sterilizing bottles and other services. Through a separate line steam is supplied to the pasteurizer at 75 lb. pressure. This extra provision was made to prevent any variation in steam pressure on the pasteurizer, the process being very exacting. During the winter season, exhaust steam is supplied to the radiators at ½ to 1 lb. pressure, the Dunham vacuum system being used.

The entire mechanical equipment of the factory as well as the power plant is under the care of Ralph Copp,

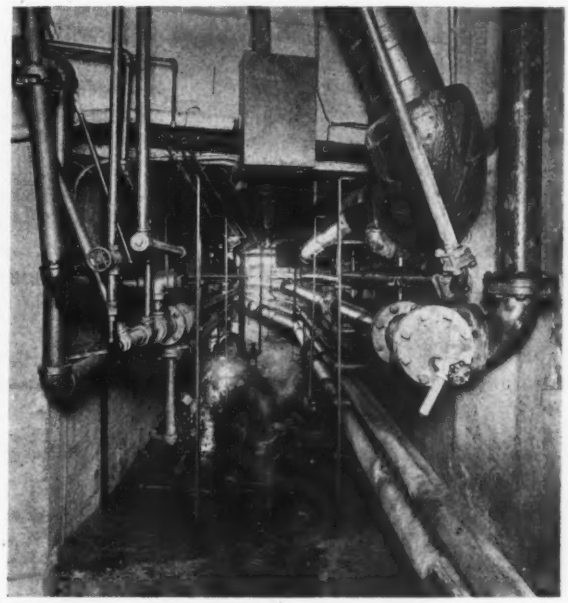


FIG. 8. VIEW IN TUNNEL BETWEEN POWER PLANT AND DAIRY

chief engineer, who has been responsible for all the engineering work connected with the design and erection of the plant.

Compressed air is obtained on a large scale without employing either steam or motor-driven or other moving machinery at a copper mine in Michigan, where about 82 per cent of the actual power of the falling water through tubes is transformed to compressed air under a pressure of 118 lb.

The air is delivered to the hoisting engine, the stamp mill power units, and to the mine proper practically dry and at the temperature of the water. The system is almost automatic, and as there are few moving parts, the upkeep is very low.

Water for compression purposes is taken from the Ontonagon River, and after passing through the system is returned to it at a point about one mile down-stream. Automatic regulation is obtained by utilizing the air pressure built up in the compressor chamber. Excessive air pressure is automatically relieved by means of an escape pipe running from the air chamber to the surface.—Mechanical World.

Two considerable water-power developments are under way in France, brought about by the need of munitions and facilities to make them, combined with the scarcity of coal. There is one installation of 20,000 hp. using water from the Alps in control of one corporation. Another development of 50,000 hp. is in the Southwest and uses water from the lakes and rivers of the Pyrenees Mountains. Before 1914, factories were very scarce in that region, whereas now there are many works engaged in making munitions.—The Valve World.

Babcock & Wilcox Boiler Construction

DESCRIPTION OF PRESSURE PARTS AND SETTING; METHODS EMPLOYED FOR REPLACING TUBES AND BAFFLES

HAVING safety as its principal feature, the first Babcock & Wilcox boiler was patented in 1867, that design having been frequently improved and modified until the present form is considered to be a standard type of water-tube boiler. Leading features are a horizontal drum and a bank of 4-in. tubes inclined about 15 deg. from the horizontal, the tubes being laid parallel in horizontal rows across the boiler, the vertical rows being staggered. The tubes are expanded into headers, which may be vertical or inclined, the front headers being connected with the drum by short tubes, while the rear connecting tubes are from 4 to 6 ft. in length.

This boiler is built in 2 forms, the longitudinal-drum type and the cross-drum type, and although the cross-drum type is well adapted for installations having limited head room, the longitudinal-drum type is more extensively used. Either design may be constructed with vertical or inclined headers, which may be of wrought steel or cast-iron, depending upon the working pressure under which the boiler is to operate.

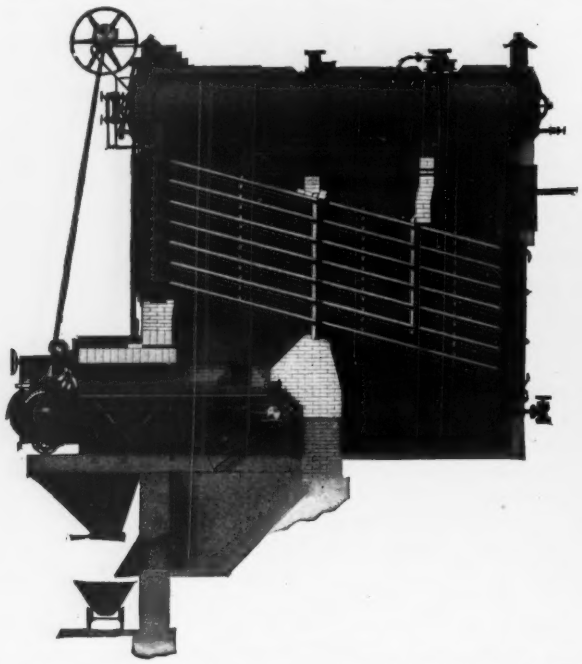


FIG. 1. VERTICAL HEADER LONGITUDINAL DRUM, BABCOCK & WILCOX BOILER

Headers may be of different lengths, that is, may connect different numbers of tubes, and it is by varying the numbers of tubes in height per section and the number of sections in width that the capacity of the boiler is varied. Handhole plates in the headers, as shown in Fig. 4, make possible the inspection of each tube for its full length. In the longitudinal drum type, the ends of the drums are connected to the circulating pipes from the headers through cross-boxes, as shown in Figs. 1 and 5, the connecting pipes being expanded into bored seats. The drums are formed in 3 sheets, the circular seams being ordinarily single-riveted lap while the longitudinal seams are properly proportioned butt and strap or lap joints depending upon the pressure to be carried.

Drums for the cross-drum type of boiler are formed of 2 sheets, and the circulating pipes from the headers are expanded into the drums at their double-riveted butt-strapped longitudinal seams, the butt straps serving as tube seats.

Connected to the circulating sections of both types of boilers at the lower end of the rear headers, is a forged-steel box 7¼ in. square, known as the mud drum. Wrought nipples, expanded into counterbored seats are used for the connections. The mud drum is furnished with handholes for cleaning and is tapped for a blowoff connection.

SETTING AND SUPPORT

BOILERS of the longitudinal drum type are suspended at the front and the rear from wrought steel supporting frames which are entirely independent of the brickwork, a construction which permits expansion and contraction of the pressure parts without straining either the boiler or the brickwork.

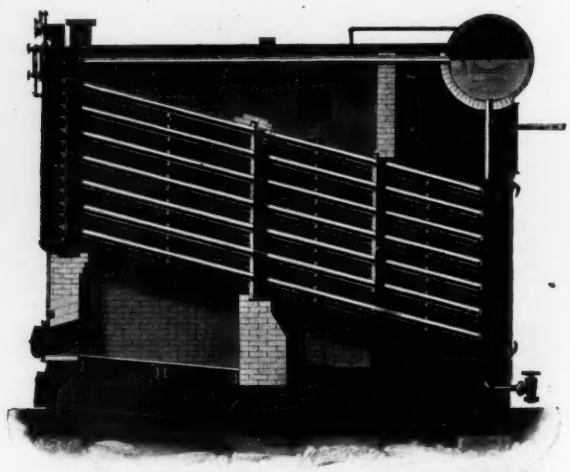


FIG. 2. CROSS-DRUM BOILER WITH VERTICAL HEADER

Cross-drum boilers are supported at the rear on the mud drum, which rests upon cast-iron foundation plates. At the front they are suspended from wrought-iron supporting frame, each section being suspended independently from the cross members by hook suspension bolts.

Babcock & Wilcox boilers may be hung at any height that may be necessary to handle properly the fuel to be burned or to accommodate the stoker to be installed. Height of the nest of tubes which form the roof of the furnace is thus the controlling feature in determining the furnace height, or the distance from the front headers to the floor line. The rear wall of the furnace

consists of a bridge wall built from the bottom of the ashpit to the lower row of tubes. By adjusting the location of this wall within limits, a depth of furnace may be secured to meet the demand of the fuel. Ordinarily the bridge wall is the determining factor in locating the front baffle.

Baffles Supported by Cast-Iron Baffle Plates

Gases of combustion produced in the furnace are directed over the heating surfaces by 2 baffles. These are formed of cast-iron baffle plates about ⅜ in. thick which are lined with special fire brick, as shown in Fig. 1, and held in position by tube clamps. The front baffle

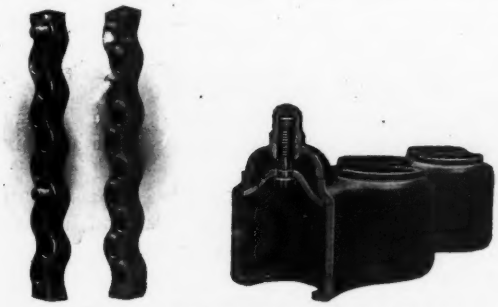


FIG. 3. WROUGHT-STEEL VERTICAL HEADER
FIG. 4. INSIDE HANDHOLE FITTINGS FOR VERTICAL HEADER

directs the gases through the forward portion of the tubes to a chamber beneath the drum or drums, and in which the superheater is installed when such an apparatus is desired. After making a turn over the front baffle, the gases are led downward through the central portion of tubes by means of a hanging bridge wall of brick and the second baffle, around which they make a turn upward passing through the rear portion of tubes and enter the stack or flue through a damper in the rear wall, or pass around the drums to a damper box placed overhead.

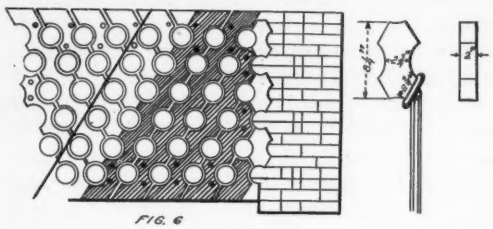


FIG. 6. POSITION OF BAFFLE PLATES

Beneath the tubes and between the front bridge wall and the rear boiler wall, a pocket is formed into which much of the soot from the gases will be deposited during their downward passage, and from which it may be readily removed through cleaning doors. Where a great depth of furnace is necessary, in which case, if the front baffle were placed at the bridge wall the front pass of the boiler would be relatively too long, a special construction with a tile roof is employed to maintain the baffle in what may be considered its normal position. This furnace construction is known as a "Webster" furnace.

Replacing a Baffle

To replace a baffle, it is first necessary to remove the old baffle bricks, prying them from the baffle plates and giving them a quarter turn so that they will drop down the diagonal space between the tubes. The bolts securing the flame plates at top and bottom should then be removed, the plates given a quarter turn and removed.

Two sets of baffle plates are used, one placed diagonally in one direction, and the other diagonally in the opposite direction, crossing each other and bolted together at the top and bottom. Figure 6 shows the manner of placing the plates from either the top tubes, furnace or combustion chamber. It is necessary to place all the plates that run in one diagonal direction before those which run in the other direction are placed. This is done by first inserting the plate in the diagonal space

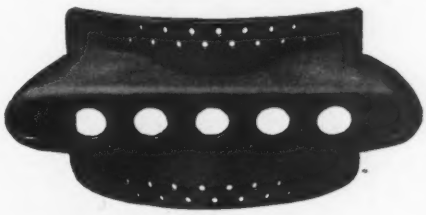


FIG. 5. CROSS BOX

between the tubes, in a position parallel to the tubes and then, when the proper location is reached, by giving it a one-quarter turn. When both sets are in place they should be secured with bolts at the top and bottom.

Three tools are employed to facilitate the placing of the tube brick. Tool A is made of a 1¼-in. square bar 6 or 8 ft. long, with a yoke secured to it 10 in. from the end. Tool B is made of 1¼-in. square bar with 2 pieces of 1-in. steel bent and secured to it about 12 in. apart. The third tool is a pair of tongs of a special design, used to handle the tube brick.

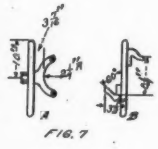


FIG. 7. BAFFLE BRICK AND TOOLS

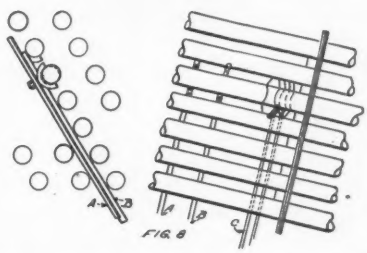


FIG. 8. SPREADING THE TUBES

Figure 8 shows tool A, which is placed between the tubes, and brought into position by twisting the end of the bar with a wrench. This spreads 2 tubes in a horizontal direction. Tool B is then inserted directly behind tool A and can be either twisted into position or inserted at an acute angle to the tubes, then pulled to a position at right angles to them. This spreads the 2 tubes acted upon by tool A, but in a direction at right angles to it, making a space large enough to insert the firebrick. These 2 tools are placed about 2 ft. from the baffle plates.

In placing the tube brick the tongs are used as shown in Fig. 7. They are fastened to the tube brick,

inserted between bar B and the baffle plates, raised or lowered as desired, in the diagonal space between the tubes. The brick is then given a quarter turn, and knocked into position against the baffle plates with the tongs. These operations are necessary in the placing of each tube brick, and if the tubes are fairly straight the bricks can be put in place readily.

Tube Replacement

Ordinarily, the method used in cutting out a tube is as follows: First, 2 slots about ¾ in. apart are cut in the bottom of the tube with a flat ripping chisel to the inside face of the seat. This narrow strip is then bent up with what is known as an oyster knife. A round nose chisel is then used for cutting the tube inside of the seat for a distance of 4 to 6 in. The slotted portion

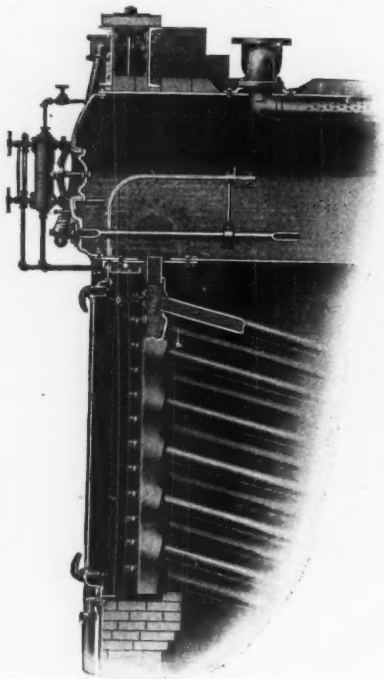


FIG. 9. METHOD OF INTRODUCING FEED WATER

of the tube is then turned in and the diameter of that portion originally as expanded to make a seat is decreased and the tube may be drawn through the tube hole. In cutting out a tube great care should be exercised not to injure the seat, that is, not to cut a groove or slot across the seat. For this reason, all cuts should be made clear of the seat.

When inserting a tube in this boiler, particular care should be taken not to injure the hanging baffle walls or main bridge wall. In expanding the ends of the tubes, especially the rear end, care should be taken to have the tube holes kept dry and clear of all dirt and sediment, so that there may be no leaks at the lower ends when expanded into the header at points not readily inspected when the boiler is in use.

Path of Feed Water

Feed water is introduced through the front drum head of the boiler as shown in Fig. 9. From this point, the water passes to the rear of the drum, downward through the rear circulating tubes to the headers, thence upward through the tubes to the front headers and through these headers and the front circulating tubes to the drum.

Steam formed in the passage through the tubes is liberated as the water reaches the front of the drum, and is stored in the steam space above the water line, from which it is drawn through a collecting pipe. As the aggregate area of the holes in this collecting pipe is greatly in excess of the area of the steam outlet from the drum, it is evident that there is no possibility of restricted flow. This pipe extends nearly the length of the drum, and draws steam evenly from the whole length of the steam space. Each drum is provided with a pop safety valve which is commonly placed at the top of the middle section.

Electricity in Foreign Countries

From the Commerce Reports of the Bureau of Foreign and Domestic Commerce are taken some interesting facts.

In Brazil some 45 light and power companies furnish service to cities creating a constant demand for pumps, fixtures, fans and small motors, which are mostly sold by hardware dealers. In Italy a private concern operates three plants to supply current to Venice and nearby cities, transmitting some 30,000 hp. from hydro-electric stations in the mountains with average loss of 10 per cent. Three-phase distribution to some 1200 users of light and 1000 users of power in Venice at 42 periods and 200 volts, and for other cities current is furnished at 50 periods and 250 volts.

Most cities in Switzerland have municipal electric plants, but Berne has both municipal and private supply, the private plant having a capacity of 40,000 hp. Motors are largely made in the country, the export value for 1915 being $2,942,480 as against imports of $186,245. As copper is scarce, aluminum is being largely used, giving a motor of larger size, but lighter and cheaper than if copper were used. Sizes up to 800 hp. are so constructed.

Owing to coal shortage, increased use of electricity from hydro-electric plants is to be expected, and electric heating for houses is being studied. German manufacturers are said to be making electric wiring devices of an alloy in which iron, lead and copper are used. It is black, non-rusting and has a resistance the same as standard lead. It is claimed to effect a great saving of lead and copper and its general adoption is contemplated.

Since the war the Swiss are making wiring devices which are outselling the German devices previously used, largely because of quick delivery.

In Venezuela an American engineer is in charge of the Maracaibo Electric Light Co. which has increased plant capacity four fold during the past year. The plant carries 3-phase, 60-cycle current at standard voltages and creates a demand for small motors.

A large Louisiana fishing company has cut down its fuel bill more than $300 a month by installing in an oyster boat a gas-producer plant which transforms coal into power gas. This gas is being burned in an explosive engine instead of gasoline.

Powdered Coal as Fuel*

DRYING, STORING, PULVERIZING AND HANDLING; AVAILABILITY OF REFUSE; RESULTS OBTAINED DURING TESTS

TO handle economically coal from the mines to pulverizing plant, it should be loaded in drop bottom cars so that they can be placed over a pit which is below track level, that the coal dropping into the hopper bottom pit will fall by gravity through a gate to a crusher and from the coal crusher to a conveyor. This conveyor delivers the coal to a magnetic separator or other suitable means used for the purpose of eliminating small pieces of metal that may have gotten into the coal; then into a boot leg or a bucket hoist which elevates the coal to a bin which also has a hopper bottom directly located over the coal dryer; from there it passes through a reciprocating feeder which can be regulated to feed the amount of coal required into the dryer. The coal passing through the dryer is dropped into another boot leg bucket hoist, where it is elevated to a dry coal bin directly over the pulverizing mill. After the coal has passed through the pulverizer it is either raised by a bucket hoist and delivered to the storage bin, or is raised from the pulverizer by air separation or blown in by a fan blast. This depends, of course, upon the kind of pulverizing mill used.

THE AVAILABILITY OF ANTHRACITE REFUSE FOR BURNING IN PULVERIZED FORM

THE AVERAGE annual output of the anthracite coal fields of Pennsylvania was, for the 5 yr. period ending Dec. 31, 1915, practically 70,000,000 tons. About 8 per cent of this total output can be considered as waste, being of such a nature that its satisfactory combustion, either in hand or stoker fired furnaces, is not possible. Some briquetting of this material has been done, but with no very marked success from the standpoint of economy.

This waste culm or slush has the following general characteristics:

AVERAGE SIZE

2 per cent through 5/16-in. round mesh and over 3/16-in.

8 per cent through 3/16-in. round mesh and over 1/16-in.

90 per cent through 1/16-in. round mesh.

AVERAGE ANALYSIS—DRY

Ash	24 per cent
Volatile Combustible	6.00 per cent
Fixed Carbon	70.00 per cent
	100.00
B. t. u.	11,500

The raw slush before drying will contain from 8 to 30 per cent (and sometimes more) moisture. It can be seen from the above that this is not very attractive fuel for ordinary firing methods and burning on grates.

The utilization of this culm in pulverized form is, however, possible and practicable, and has been in use at a colliery in the Scranton district of Pennsylvania for about 2 yr. Drying, pulverization and handling is accomplished in the usual manner, the product averaging about 14 per cent through a 100 mesh screen and 86 per cent through a 200 mesh. No difficulty is experienced in handling, but the wear on the type of pulverizer in use is somewhat higher than when straight bituminous is being worked.

Where anthracite culm is available the problem of its use as a fuel can be solved to satisfaction by pulverization and burning in suspension as above described and from the broader standpoint of economics this is certainly to be preferred to building up the vast culm banks found in the anthracite region, or using it as back-filling into exhausted workings or wasting it in streams and rivers, only to be later reclaimed by dredging processes.

There is a large Stirling boiler of 463 rated horsepower in the plant of the Delaware & Hudson, which operates very successfully with the straight pulverized anthracite. When starting up this boiler, pulverized bituminous is used until the refractory material in the boiler furnace is well heated, after which anthracite is burned alone and very satisfactorily. From test reports of the railroad company a maximum evaporation of over 27,000 lb. of water per hour, corresponding to 170 per cent rating, has been attained, and under average working conditions the boiler delivers about 130 per cent of rating. In both cases the continuous CO_2 recorder shows an average of about 16 per cent. The maximum observed equivalent evaporation from and at 212 deg. was 9.6 lb. of water per pound of dry coal, and the average was 8.9 lb. These results are very good when compared with hand-firing of steam sizes of anthracite coal in stationary boilers of this type. Under these latter conditions, an evaporation of from 5 to 6 lb. of water which may be attained with an average flue gas CO_2 content will run from 10 to 12 per cent. The matters of fire cleaning and removal of slag and clinkers are respectively eliminated and very much simplified by the use of pulverized anthracite, and it is safe to say that its use will double the horsepower output of any good sized modern stationary boiler now burning buckwheat or other prepared sizes of anthracite. The use of this fuel will also release other and more valuable (commercially) coals to the general market and reduce the boiler plant labor from 30 to 50 per cent.

Additional data giving the results accomplished from tests of the inferior grade of anthracite follow:

TESTS ON STIRLING TYPE BOILER WITH PULVERIZED FUEL

Test No.	1	2	3
Duration, hours	336	48	240
Horsepower rating	463	463	463
Horsepower developed, per cent	135	178	118
Fuel	Anth.	Anth.	Anth.
Kind	B. E.	B. E.	Slush
Dryness, per cent	0.65	0.65	0.8
Fineness, per cent through 200 mesh	86.0	86.0	86.0
Evaporation from and at 212 deg. F. lb.	8.9	9.8	8.1
CO_2 average per cent	16.3	16.6	16.5
Vacuum in breeching uptake, in. of water	0.23	0.33	0.28
Vacuum in combustion chamber, in. of water	0.14	0.16	0.19
Boiler pressure, average lb	142	140	144
Flue gas temperature, deg. F. average	525	603	580

*From the report of a committee of the International Railway Fuel Association.

No comparison of anthracite slush, pulverized and not pulverized, is available, as it is not burned on grates. However, comparing the performance of anthracite bird's-eye, hand fired, on grates equipped with forced blast below and induced draft above the fire, and the same fuel pulverized and burned in suspension, there is an increase of over 40 per cent under the latter conditions.

It may be stated generally that the steam generating capacity of the boilers now burning bird's-eye anthracite on grates is about doubled by the use of pulverized anthracite slush, and at the same time the boiler plant labor cost is reduced about 40 per cent, account of it not being necessary to clean fires, and lessened amount of ash to be handled when all boilers are equipped for burning fuel in pulverized form.

Development of the Missouri, Kansas & Texas Railway

The Missouri, Kansas & Texas Railway Co. reports that an equipment for burning pulverized fuel on two stationary boilers at their Parsons power plant, was completed May, 1916, together with the facilities for fuel drying, pulverizing, storing and disbursing. The boiler plant consists of four batteries, each of two 250 hp., Heine-O'Brien type of boilers, set originally for burning natural gas.

At first two boilers were equipped for burning pulverized fuel, and put in use June 1, 1916. The quality of the combustion produced was satisfactory, but due to the boilers having horizontal baffling, it was impossible to keep them clean and to prevent the flues from choking. This was overcome by building a dutch oven, adding side cleaning doors, and changing baffles from horizontal to vertical.

These alterations produced such an improvement when burning pulverized fuel that it became necessary to make similar changes under each of the other boilers before equipping them. At present, six boilers are in permanent use burning pulverized fuel, and have been in continuous operation as follows: Nos. 7 and 8, since Aug. 5, 1916; Nos. 5 and 6, since May 10, 1916; and Nos. 3 and 4, since Dec. 17, 1916. The remaining two boilers will be equipped at once, but no dutch oven will be used, as on these the fuel will be fed from underneath the floor instead of from the end and upper floor.

Coal from three districts has been used, having about the following proximate analyses:

	Fixed carbon	Vol. matter	Ash	Moisture	B.t.u.
Lignite—Texas	25	34	8	33	11,250
Slack—McAlester, Oklahoma	47	33	14	6	12,630
Slack—Southern Kansas	45	27	20	8	11,580

The first tests with lignite proved unsatisfactory on account of the inability to reduce the moisture content with the drying equipment then in use. This defect has since been remedied, so that now lignite may be successfully dried and used. The fuel now being used is southern Kansas slack from Mineral, made over a two-section shaker screen, 72 sq. ft. with 0.625-in. round perforations, and 72 sq. ft. with 0.800-in. round perforations, which removes about 25 per cent of the coal.

Data from several trials show a furnace and boiler efficiency of about 69 per cent for lignite, 68 per cent for McAlester slack and 61 per cent for southern Kansas slack.

The cost of preparing the fuel is given as $1.17 per 2000 lb. for lignite, $0.34 for McAlester slack and $0.35 for southern Kansas slack.

Boiler trials using natural gas at $0.125 per 1000 cu. ft. show a cost of $0.16 for evaporation of 1000 lb. water from and at 212 deg.; while the average cost when using southern Kansas slack is $0.12, a saving of 25 per cent in favor of pulverized fuel. A comparison of tests made with lignite, however, does not show any saving in cost, which may be due to the trouble experienced in reducing the high moisture content of lignite.

The smokestacks are set quite low (62 ft.) giving only about 25-in. draft. Notwithstanding this low draft, combustion is so nearly complete that no smoke is apparent. A fine gray ash is visible, however.

It may be of interest to state that a carload of front end locomotive cinders was placed by accident in the power plant; dried, pulverized and burned without the least inconvenience.

No case of fire or explosion has occurred with the use of pulverized fuel. The damp coal stored in the plant prior to preparation has developed spontaneous combustion, but this has occasioned no other precaution than to stop feeding until the hot coal has been removed. A magnetic separator is used, which has fully demonstrated its utility.

Thorough examination of the boilers at wash-out periods revealed no flaws, cracks or deterioration at any point in the furnace. A thin scale of glaze about ¼ in. thick covered the entire brickwork, but with no accumulation of slag. Baffles and bridges are intact after 98 days' service, and indications are that the walls with pulverized fuel will outlast those with other methods of firing.

In inaugurating the use of pulverized fuel many obstacles had to be overcome and adjustments made to suit local conditions before practical operation was attained. But all troubles have now been "ironed out," and ever since placing the equipment in permanent use on the dates mentioned, there has never been any lack of steam. This notwithstanding its being a fuel unfamiliar to the employes, severe weather, and being compelled to use almost any kind of fuel available. It has been demonstrated that pulverized fuel is an efficient and successful fuel for stationary boilers.

Before 1880, electricity was sparingly used—the first central station for arc lighting had just been established in 1879. Its recognition as a source of energy for universal lighting, for propulsion, for power, and for heating—for all the large and vital uses it could be put to—was a matter of speculation, and not one of expectedly near realization. No one, even of the wildest imaginings, could have dreamed of the transformation so close to hand. But before this census period closed, the electric incandescent lamp was incontestably established, the trolley car was successfully introduced, the central station for power distribution and the polyphase motor for stationary work began to show their revolutionizing possibilities, and the first electric furnace was put into successful commercial operation.—The Valve World.

Centrifugal Pumps

DEVELOPMENT, TYPES, APPLICATION TO VARIOUS SERVICES.

BY H. S. BUDD*

FOR many years, the centrifugal type pump was considered useful only for handling large quantities of water at low heads and was uneconomical to operate. The development of the steam engine and its application to direct acting steam pumps kept the centrifugal in the background where it remained almost forgotten for many years. With the introduction of electricity and motor drives, and, later on, steam turbines, however, there arose a demand for a pump that could be direct driven at comparatively high speeds, and the centrifugal pump has been improved and refined to meet this requirement.

This development has been along purely scientific lines, with quite wonderful results until these pumps now operate with surprisingly good performance and economy on nearly all classes of both high and low head service for which only reciprocating pumps had formerly been used. The simplicity and compactness of construction, smoothness of operation and freedom from shock and water hammer all appeal immediately to those familiar with pumping machinery.

TYPES

CENTRIFUGAL PUMPS as built today are of two general classes, namely, open and enclosed impeller types, depending on the type of impeller used.

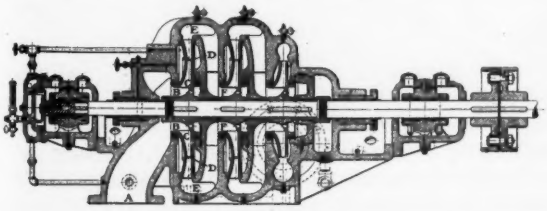


FIG. 1. SECTIONAL VIEW OF THREE-STAGE PUMP EQUIPPED WITH KINGSBURY THRUST BEARING

Open impellers consist of a number of arms or vanes radiating from a hub in the manner of an ordinary centrifugal blower. The sides of the vanes are usually faced off and run close to the walls of the casing on both sides in order to prevent, as far as possible, the slippage of the liquid being pumped. Open impellers are adapted to handling liquids containing some solid matter on low heads that would tend to hang or clog in the enclosed impeller types.

Inclosed impellers consist of blades or vanes of suitable curvature radiating from a hub and enclosed by two disks or walls. The liquid to be pumped enters at the center or eye of the impeller around the shaft on either one or both sides, depending on whether it is of single or double suction type, and passes through the wheel in channels formed by the walls and vanes.

Double suction impellers which are subjected to the same pressure conditions on either side are automatically balanced against thrust along the line of the shaft for all ordinary operating heads.

*Sales Engineer, A. S. Cameron Steam Pump Works.

Single suction impellers are not so completely balanced and therefore require end thrust bearings.

As the enclosed impeller handles the liquid being pumped through confined passages or channels of definite form with a limited amount of disturbance or leakage, a capable designer can quite accurately control the performance of the pump over a broad range of operation. For this reason, the enclosed impellers are used for all medium and high head pumping equipment and when high efficiency is desirable.

SINGLE STAGE PUMPS

A SINGLE STAGE pump contains one impeller and can be built for almost any capacity and reasonably high head with efficient results, the larger sizes being more economical, of course, than the smaller.

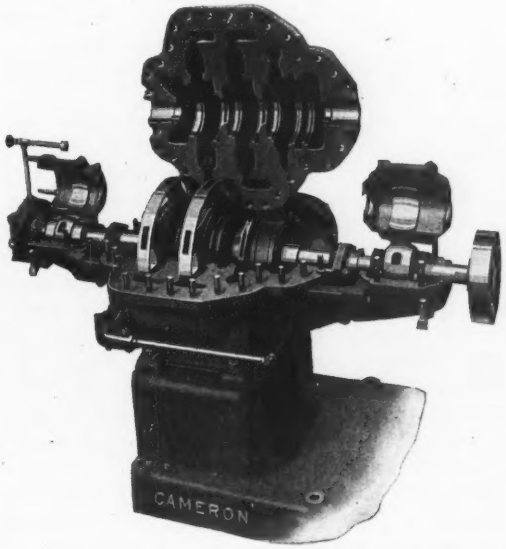


FIG. 2. THREE-STAGE PUMP WITH CASING OPEN SHOWING CONSTRUCTION OF IMPELLERS

The greater the head created by a single impeller, the greater will be the difference in pressure between the suction and discharge chambers of the pump. This is accompanied by a greater internal slippage and leakage and more rapid destruction of the internal parts, and therefore is one of the factors that determine the greatest pressure or head allowable per impeller or stage.

MULTI-STAGE PUMPS

FOR HIGHER heads, multi-stage or turbine pumps are used consisting of two or more enclosed impellers on the same shaft, and running in a casing with passages so arranged as to lead the liquid through the several impellers in succession, each one adding its equal share of the total pressure desired. By this means pressure of several hundred pounds may be obtained from a single pump, the limit depending on the mechanical limitations of design, strength of materials used and their resistance to abrasion by the liquid at high velocity.

In multi-stage pumps, the liquid discharged at high velocity from all but the last impeller must be abruptly turned through 180 deg. to enter the eye of the succeeding one, and suitable vanes known as diffusers are provided to reduce the speed of this water as far as possible, and convert it into pressure as soon as it leaves the impeller, so that it may be conducted into the succeeding one with the least disturbance and impact on the walls of the casing.

All multi-stage pumps require some means of maintaining correct alinement of the rotating element with the passages in the casing and of equalizing any end thrust that may be present. In pumps handling clean fresh water, this is best accomplished by means of an internal hydraulic device in which the thrust is carried on a body of water confined by a suitable piston or diaphragm mounted on the shaft. This device is quite simple in construction, yet it automatically and promptly adjusts itself to varying load conditions and being a water bearing with no metal contact, operates with practically no loss of power. Where the liquid being pumped carries grit or solid matter that would tend to wear the parts of the hydraulic balancing device rapidly, a step bearing of the Kingsbury or Marine thrust type external to the casing should be substituted.

The operating principle of a centrifugal pump is quite simple. The liquid pumped is accelerated by passing it through a revolving impeller, creating both pressure and velocity and the velocity is then converted into pressure in the stationary discharge passages; however, it becomes a very complex problem to design and build a pump to deliver a given quantity of liquid against a specific head at a definite fixed speed and to accomplish this at the highest efficiency. A capable designer can predict within a small percentage of error both the performance and the brake horsepower required, not only at the normal operating point, but over a range, from a condition of free discharge against no head, to a closed discharge and no liquid flowing.

Each installation is a problem by itself and must be treated as such, if definite results and highest efficiency are to be realized.

Application and Uses

Centrifugal pumps may be driven direct or through belt or gear from electric motor, steam turbine or engine, or other source of power, as best suits the requirements of the particular installation.

Direct connected to steam turbines they make highly satisfactory steam operated units. They operate on less steam and require less lubricating oil than ordinary steam pumps. They occupy small space, and their advantages in freedom from valves, valve motion, and rubbing parts are all too evident to need further comment.

Water Works Service

Motor driven centrifugal pumps have met with great favor on water works service in small towns and villages. When operated in connection with standpipe or elevated tank, they may be arranged to be automatically started and stopped by means of a pressure regulator or float switch. When used with a direct pressure system, the pump or pumps may be run continuously maintaining the pressure and delivering only such water as is drawn from the mains. In localities where a part of the district supplied is on a higher elevation or some distance away requiring an excess pressure, it is found expedient to maintain a domestic pressure at the pumping station suitable for the greatest demand and to insert a centrifugal in the main that supplies the higher pressure. Such an installation is known as a booster pump and it may float on the line continuously, adding a fairly constant net pressure irrespective of the amount drawn from that line. It is often the practice to use a moderate pressure in water mains for domestic service and to increase it materially in case of fire. As motor driven centrifugal pumps are preferably constant speed machines and therefore suitable for one pressure only, it is quite common in cases of this kind to install two or three duplicate pumps designed for domestic service and operating two in series to obtain increased pressure for fire service.

Quite a large number of turbine driven centrifugal pumps, running condensing, having been installed where in former years only crank and flywheel pumps would have been considered, and the improvement both as to reliability and economy has been so marked that at present their performance rivals the best triple expansion crank and flywheel pumping engines in total yearly operating cost, when due allowance is made for all interest and standing charges on the capital involved. These charges, of course, greatly favor the centrifugal unit on account of its comparative low first cost, together with that of the smaller building, lighter foundation, etc.

Boiler Feeding

Among the many uses of the centrifugal pump, boiler feeding is a service for which it is ideally suited and has attained great favor. The pump is usually driven electrically or by steam turbine, whichever is best suited to the particular installation. In operation, the motor driven boiler feeder is generally allowed to run continuously at full speed, maintaining a fairly constant pressure on the feed line for a considerable range of capacity. The amount of water fed to the boiler may be controlled by a throttle valve in the feed line without danger of creating a dangerous increase in this line, as the centrifugal will not build up a pressure exceeding 15 to 20 per cent above normal pressure, even when the discharge is entirely closed. Steam turbine driven boiler feeders are sometimes operated in this manner also, but they are more often equipped with pressure regulators of a type similar to those used on ordinary steam pumps to maintain a constant differential between the steam and the feed line water pressures, especially where the variation in steam pressure is considerable. Whether driven by electric motors or turbines the feed of the water to the boiler can be regulated without reference to the pump, and further, there are no valves or large packings to be maintained, nor is there danger of water hammer and breakage in case of loss of suction as with reciprocating pumps.

Efficiency

The efficiency of any centrifugal pump is highest at only one combination of head and capacity for each

change in speed, and therefore if a pump is operated on a head or at a speed other than that for which it is designed, the amount of delivery and power required can be only approximately predicted. At the same time, the efficiency would likely be very low, making the installation quite unsatisfactory for the work it was intended to do, as well as expensive in cost of power for driving.

Wearing Parts

There are a few parts of the enclosed impeller type of pump that are subject to the greatest wear; namely, that part of the casing which makes a running joint with the impeller, the section of the shaft within the stuffing boxes and the bearings. If these wearing surfaces are provided with renewable parts that can be replaced at small expense, the main and more costly parts, being protected, will last almost indefinitely, insuring a low cost of maintenance. Wearing rings secured in the casing around the impeller inlet protect the case from wear at this point, and a smaller pair of rings made of bronze and secured on the impeller protect it from wear also. Bronze sleeves secured on the shaft and passing out through the stuffing boxes relieve it entirely from scoring by the packing, or rusting. By supplying the bearings with removable ring oiled split babbit lined shells of the spherically seated type which may be easily slipped out when worn, and either rebabbited or replaced by a new set, the alinement of the rotating element will not be disturbed, and the close fit between the impeller and case so necessary to prevent internal leakage, will be preserved.

Operating Conditions

It will readily be appreciated from the foregoing that in building a centrifugal pump for a particular installation, it is essential that the conditions of head, capacity and speed be accurately determined and furnished to the designer, together with any special requirements involved, especially if the highest efficiency is expected. It is not to be understood from this that the centrifugal pump is an extremely sensitive affair that will be efficient at one particular combination of head and capacity only, and of low economy when these ideal conditions do not obtain. The efficiency will remain nearly constant for a small variation in head both above and below the normal, the capacity varying inversely as the head, consequently it is usually safer to figure the total head a trifle high and design the pump accordingly, and then if the head is actually less, a slight increased capacity will result, which is not usually objectionable.

Very often two or more conditions of head or capacity can be obtained from a pump of special design running at constant speed with a satisfactory balance of efficiency, and with provisions for some speed variation the possibilities of designing for carrying service are greatly increased.

Total Head

The total head on which a pump has to operate is made up as follows: Vertical static suction lift from the level of the liquid in a well or sump to the center of the pump, static discharge head measured vertically from the center of the pump to the point of discharge, friction in the piping, valves and elbows of both suction and discharge lines, velocity head, and entrance head. In addition the pump must overcome the loss of head within itself, but the builder only is concerned in this, and the efficiency of the pump is the ratio of the theoretical power required in raising the given quantity of liquid against the total head, to the sum of this power plus the hydraulic losses in the pump, and the friction in bearings and stuffing boxes. This sum is known as pump horsepower.

Effect of Speed Variation

Both the total head and the capacity of a centrifugal pump are quite sensitive to speed variation, therefore great care must be exercised in determining the speed at which a pump is to operate in order that it may be designed accordingly. This is particularly essential when the pump is to be direct connected to a constant speed alternating current motor of which the speed at full load is several per cent lower than at no load, and there

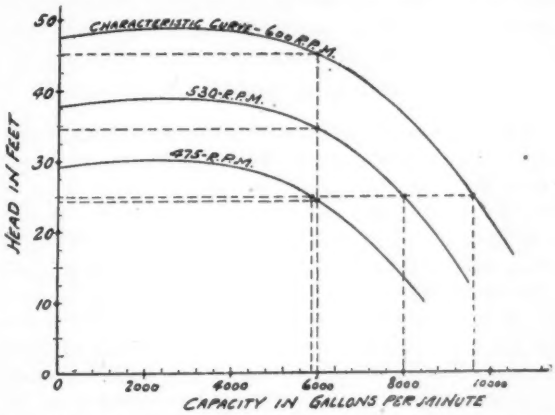


Fig. 3. Characteristic curves of centrifugal pump

is no convenient way of altering the speed of such a motor.

Priming

A centrifugal pump cannot raise a liquid to itself from a lower level without first being primed, because it possesses no positive displacement feature and therefore both the pump case and suction piping must be entirely filled before starting. Priming may be accomplished either by providing a foot valve on the lower end of the suction line and filling the pump and suction piping from the discharge line or other source, or by drawing the liquid up into the pump through the suction pipe by exhausting the air from the top of the pump case. With this latter method the discharge must be closed off by means of a gate-valve, and the foot-valve may be dispensed with if desired, provided the pump is started while it is primed. The air may be withdrawn from the pump by means of a suction pump, steam injector, or other means of creating sufficient vacuum to fill the pump case with water.

Suction Lift

Once in operation, a centrifugal pump will handle water or other liquid of the same specific gravity and

character at ordinary temperature on as great a suction lift as a reciprocating pump, namely, about 26 ft. at or near sea level, and provided the suction piping and pump are entirely free of air and air leaks.

Because of the difficulty sometimes encountered in maintaining air-tight suction glands and piping, 18 ft. is usually considered the maximum commercial suction life, and even less is advisable whenever possible.

The limit of suction lift decreases with the rise in temperature of the liquid on account of the increased vapor tension, and it is not advisable to undertake any suction lift with water at a temperature exceeding about 150 deg. F., but rather have the pump so located that the water will flow into it by gravity. When handling water at or near the boiling point, as in boiler feeding, the water should flow to the pump under a head of from 6 to 10 ft., and the suction piping should be as direct as possible and of large diameter to eliminate the formation of vapor. Vapor, or air or other gas in the pump in considerable quantity, will collect within the suction opening of the impeller, being the point of least pressure, impede the passage of the liquid, reducing the capacity of the pump, and at times causing it to lose its suction entirely.

Size of Piping

Bearing in mind the marked advantage of small suction lift, the intake pipe should be as short and direct as possible, with absolutely tight joints. It is usual to make the intake pipe and foot valve at least one size larger than the pump inlet to reduce friction, which, of course, adds to the suction lift. As the basic principles of the centrifugal pump require the liquid to be handled at high velocity, the suction and discharge openings are much smaller than are usual in reciprocating pumps of equal capacity, and the sizes of both the intake and discharge pipe lines should be determined from the amount of friction in the required length, which can be learned by referring to standard published friction tables.

Installation

Centrifugal pump installations are usually provided with a gate valve in the discharge to shut the pump off from the line when not in use, or open for inspection.

There is nothing in a centrifugal to hinder the liquid flowing backward through it from the discharge line when not in operation, and consequently in case of a sudden shutting off of the power, the impeller acting as a water turbine, may be revolved backward at a speed dangerous to both the pump and prime mover. A foot valve on the intake pipe will prevent this occurrence, or if this is not provided, a check valve should be located in the discharge. Where the operating pressure is great and a foot valve is employed, there should also be a check in the discharge to reduce the shock on the pump case when the foot valve seats. The check valve should be provided with a bypass in order to prime the pump should the foot valve leak.

In placing suction and discharge pipe lines, they should be free from high spots or loops forming pockets in which entrained air may accumulate, as the air bubbles thus formed will offer considerable resistance to the movement of the liquid by obstructing its passage, and in case of the suction pipe they are liable to enter the pump in such quantity as to cause loss of suction entirely.

Development in Blast Furnace Blowing Engines

IN blowing engines, the course of development has been following rather unexpected lines. By comparison of the number of new furnaces built with the number of new blowing engines and new turbo blowers installed, it is found that a comparatively small amount of new blowing equipment has been added. This is explained by the fact that a large number of existing blowing engines have been rebuilt in such a way as to have a larger capacity and to serve a greater number of furnaces than heretofore. The possibility of increasing the capacity of existing blowing engines is largely due to the increase in piston speeds made possible by the introduction of plate valves.

This rebuilding of blowing engines is, in some cases, limited to the simple replacing of the existing valves by automatic plate valves. In other instances, it means the removing of old cylinder heads and replacing them by heads containing plate valves. In the most extreme cases, it means the removal of the whole air end, including the air cylinder.

The fact that plate valves allow higher piston speeds is beneficial in several ways. Right now, due to poor grade of coke available, many furnaces are troubled by the necessity for more air than was used in the past when better coke was on hand. More air means not only more pig iron, but in addition, more furnace gas, more steam and steady, profitable operation.

Installation of plate valves, and the resulting possible increase in speed of the blowing engines, has enabled a number of plants to erect another furnace without installing additional blowing units. The former practice of blowing a furnace with three or sometimes four tubs, has given way to the present possibility of blowing a furnace with two tubs only; and, in fact, a great many furnaces in this country are being blown today, using only two 84-in. diameter blowing tubs equipped with automatic plate valves, so that the blowing capacity of existing plants can be increased 50 to 100 per cent by equipping the present engines with automatic plate valves.

The New York School of Heating and Ventilating announces the opening of the fifth annual season, 1917-1918, in Room 512, World Building, New York City. The first year class will meet Monday evening of each week at 7:30; the second year, Wednesday evening of each week at the same hour. Both classes will be under the direction of Charles A. Fuller, consulting engineer with Messrs. Clark, MacMullen & Riley. No particular requirements are necessary for the first year course, as the various subjects are handled in such a manner as to eliminate the more difficult mathematical calculations. Before entering the advanced class, it is desirable to complete the first year course or present necessary qualifications. The fee for each complete course will be $15, payable in advance. The first meeting for registration in both classes will be held on Monday, Oct. 1.

Electrical Machinery and Appliances

For Generating, Transmitting and Using Current

Power Station Costs

ITEMIZED ACCOUNT OF EXPENDITURES REQUIRED FOR A 10,000-KW. STEAM-ELECTRIC PLANT. BY JOHN D. MORGAN

ALTHOUGH engineers are of necessity always more or less acquainted with the physical side of the plants under their care, they seldom gain access to records from which they may learn more relative to the financial side of their work. This is true of both installation and operation costs, especially the former. As in all engineering work, design and location play an important part in installation costs and no article on this subject is complete without considering design or operating features.

The station I have in mind was designed for the ultimate installation of 3 5000-kw. generators, although but two of these units were installed, thus giving the plant an initial capacity of 10,000 kw. The plant, a combined generating and substation, is located along a navigable salt-water river; current is generated at 13,200 v., 3-phase, 60 cycles. In designing, a water rate of 20 lb. per kilowatt-hour was provided for.

All prime movers are operated condensing while the steam-driven auxiliaries exhaust into open feed-water heaters which maintain the boiler feed water at a temperature of 210 deg. F. Steam is generated at 200 lb. gage and is superheated at an average of 150 deg. F., no saturated steam being in use.

Salt water is employed for all station purposes except as boiler feed and from the cooling of the transformers; rain water is drained into cisterns and is used for sealing glands. Fresh water is obtained from the local water company.

TABLE I. POWER STATION EQUIPMENT COSTS

Item	Cost	Item Unit Cost	Unit Cost per Kw. of Station Capacity	Item	Cost	Item Unit Cost	Unit Cost per Kw. of Sta. Capacity
8 - 600 Hp. Boilers, Stokers and Superheaters	118704.00	34.75		1 - 150 ton Coal Unload Tower with Foundation	38450.80		3.845
Boiler Equipment	3533.20	0.536		1 Incline Coal Conveyor with Steelwork & Foundation	14911.23		1.4911
Ash Hoppers	7412.45	1.545		Electric Coal Recording System	83.00		0.0083
Total Boiler Costs	129649.68		12.965	Boiler Compound Mixing System	51.94		0.0052
No. 1 Main Unit, 5000-Kw., A.C.				Drinking Water Cooler & Filter	839.93		0.085
Turbo-Generator	45000.00	9.00		2 - 150-ft. Brick Stacks	16300.00		1.630
Equipment	1021.82	0.204		2 Damper Regulators	201.30		0.0201
Auxiliary Oil Pump	105.10	0.021		Turbine Oiling System	262.62		0.0263
Surface Condenser & Equipment	13239.66	2.647		Station Piping	41131.90		4.1132
Air Pump & Equipment	1956.94	0.387		75 Panel Switchboard (Material Cost)	41319.99		4.132
Circulating Pump & Equipment	3973.84	0.795		2 - 500-Kw. Rotary Converters	15882.00	15.26	3.139
Condensate Pump & Equipment	621.57	0.124		1 - 500-Kw. Rotary Converter	6011.00	12.022	
Instrument Panel & Equipment	457.95	0.091		Transformers (Total 3580 Kw.)	10035.59	2.796	1.003
Total Unit	65356.65	13.07		3 - 71-Kw. Constant Current Transformers	1944.00		0.1944
No. 2 Main Unit, 5000-Kw., A.C.	65819.09	13.164		9 Potential Regulators	4697.77		0.4698
Total Main Units	130674.74		13.067	Battery Charging Set	317.00		0.0317
3 - 100-Kw. Turbo Exciters & Equipment	10613.40	35.38	1.061	Storage Battery	853.00		0.0853
2 Open Feed Water Heaters & Equipment	3643.14		0.3643	Lightning Arresters	2336.94		0.2337
2 Venturi Water Meters, 160,000 lb. Capacity	1276.00		0.1276	Ground Detectors	200.88		0.02
3 - 4-in. Water Meters	295.00		0.0295	Electric Apparatus	379.36		0.0379
3 - 3-in. Centrifugal F. W. Pumps & Equipment	3540.18		0.354	Compressed Air System	1100.23		0.110
3 House Service Pumps & Equipment	1008.95		0.1009	Generator Air Intake Ducts	1028.26		0.1028
1 Fire Pump	1289.19		0.1289	Signal System	9.71		
1 Oil Pump	154.85		0.0155	Traveling Crane	7475.00		0.7475
7 Steam Traps	293.21		0.0293	Protecting Screens	120.82		0.0121
Station Gauges	368.92		0.0369	Aluminum Signs & Tags	36.97		0.004
Pyrometer System	348.80		0.0349	Pot Heads	74.82		0.0075
Tanks	2597.42		0.2597	Spare Electrical Apparatus	1646.57		0.1647
Waste Washing Machine	257.00		0.0257	Conduit & Duct	2771.75		0.277
Drip Pans	62.95		0.0063	Control Wire & Duct	4398.69		0.4397
Breeching	9564.19		0.9564	16840 Ft. of Cable	9971.13		0.9971
Motor Stoker Drive System	646.57		0.0646	Tools & Supplies	6006.80		0.6006
Mechanical Draft System	5437.07		0.5437	Station Laboratory	598.51		0.0598
Coal Siftings Reclaiming System	598.18		0.0598	Machine Shop	2360.00		0.236
4 Weighing Type Coal Chutes	520.00		0.052	Electrical Installation Labor	13462.20		1.3462
Narrow Gauge Tracking System	3011.00		0.3011	Busses	8324.08		0.8324
Standard Gauge Tracking System	2260.00		0.2260	High Tension Switch Compartments	1813.01		0.1813

Bituminous coal is used in the furnaces, which are stoker fired and equipped with forced draft.

Following is a list of the principal equipment:

2—5000 kw.-horizontal, double-flow turbines, 180 lb. steam pressure; 150 deg. F. superheat; condensing, and each direct connected to a 5000-kw., 13,200-v., 3-phase, 60-cycle, alternating-current generator.

3—100-kw., 125-v. noncondensing turbine-driven exciter sets.

3—500-kw., 13,200 to 600-v. direct-current rotary converters.

3—1000-kv.a., 13,200-v., 3-phase, to 2400-v., 2-phase, oil-filled and water-cooled transformers.

Boiler Room

8—600-hp. horizontal water tube boilers equipped with superheaters and placed in batteries of 2 each; all are steel encased.

2—Open feed-water heaters.

3—3-in. turbine driven centrifugal boiler feed pumps.

Switchboards

1—6-panel high tension board.

1—4-panel recording instrument board.

1—4-panel bench board.

1—4-panel 2400-v. station board.

TABLE II. SUMMATION OR STANDARD ACCOUNT CLASSIFICATION

	Cost	Cost Per K.W.	Cost Per B.Hp.	Percentage Distribution of Machinery Cost	Percentage Distribution of Total Station Cost
Furnaces, Boilers & Acces.	$244606.87	$24.46	51.00	45.5	28.7
Steam Engines	39315.39	3.93	8.19	7.3	4.6
Turbo-Generator	103896.49	10.39	21.63	19.3	12.2
Acces. Elec. Power Equip.	126444.56	12.64	26.76	23.9	15.1
Acces. Power Plant Equip.	21560.05	2.16	4.50	4.02	2.5
Total Machinery Cost	537842.36	53.78	112.10	100.00	63.1
Total Bldg. Cost	314021.00	31.40	65.40		36.9
Total Station Cost	851863.36	85.186	177.50		100.0

1—5-panel 120 and 240-v. station board.

1—3-panel exciter board.

1—23-panel railway and commercial board.

2—Generator field panels.

3—Series lighting panels.

2—Regulator panels.

1—Storage battery charging panel.

Miscellaneous

1—10 by 10 by 8-in. locomotive type air compressor.

1—9 by 10 by 12-in. horizontal simplex reciprocating air compressor.

1—35-ton, 53-ft. span motor operated crane.

1—Inclined belt conveyor.

1—150-ton coal unloading tower.

1—Machine shop.

1—62-cell storage battery and motor generator charging set.

The building is a steel and brick structure erected on a concrete mat resting on piling; the total cubical contents of the mat being 211,247 cu. ft. The cubical contents of the building above the mat is 1,614,811 cu. ft. The cost of the building, including dock, lawns, fences, sidewalks, bulkhead retaining walls, stacks, coal bunker, machine foundations and standard gage track, was $314,021, or $31.40 per rated kilowatt of the station.

In Table I are given all the various equipment costs. These do not represent the costs as of today, but are the figures employed prior to the war, or, in other words, as of Jan. 1, 1916.

Electric Heater For Three-Wire Circuit

By Terrell Croft

IN THE Northwest part of the United States where electrical energy is supplied at low cost it is used to a considerable extent for room heating. A characteristic feature of electric heaters is that they are practically 100 per cent efficient; that is, all of the

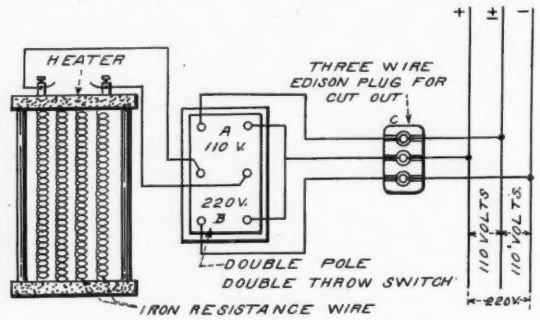


FIG. 1. SHOWING CONTROL ARRANGEMENT FOR ELECTRIC HEATER

electrical energy which goes into the heater reappears as heat.

Figures 1 and 2 show how a heater was arranged for operation on a 110-220-v., 3-wire circuit. In mild weather the heater was connected across 110 v. by throwing the switch to position A, Fig. 1. In severe weather it was connected across 220 v. by throwing the switch to the B position. As suggested in the illustration, the apparatus was protected against overload by a 3-wire

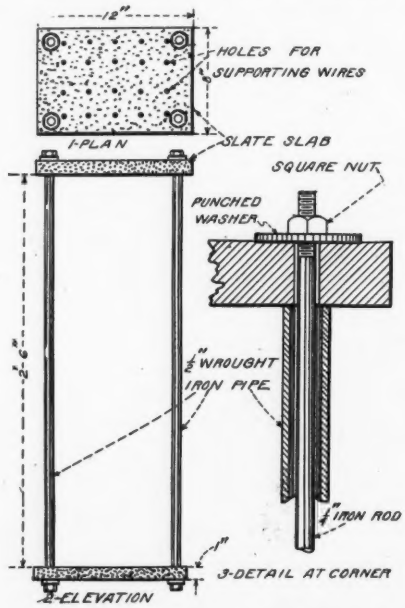


FIG. 2. DETAILS OF CONSTRUCTION OF RESISTOR SUPPORTS

Edison plug cutout, C. The heater was used and gave satisfactory service in a small room located in a warehouse. The room was 13 ft. long, 20 ft. wide and 12 ft. high. It had two windows and a glazed door.

Figure 2 shows the details of the construction of the resister supports. Slate slabs 1 in. thick were used at each end. The slabs were tied together with four ¼-in. tie rods; ½-in. wrought iron pipe was used for spacers. Only noncombustible materials were applied in the construction of the device. The resistor coils were supported by passing the ends of the resistor wires through holes drilled through the slate slabs and bending them over. All of the coils were connected in series. No. 13 Birmingham wire gage galvanized iron wire was used for the resistor and approximately 1000 ft. or 25 lb. were required for the heater.

Operating a Compression Ammonia Plant

KEEP THE AMMONIA CHARGE PURE, JOINTS TIGHT, COILS CLEAN AND EXPANSION VALVES PROPERLY SET. THE EFFICIENCY WILL TAKE CARE OF ITSELF. BY E. W. MILLER

IN operating a refrigerating plant, the main points are to keep a good charge of ammonia in the system, keep the charge pure, eliminate and prevent leaks, keep the condenser and expansion coils clean inside and outside, watch the stuffing box, if it is a compression system, and last, but probably the most important of all, watch the expansion valves.

The ammonia charge should always be kept so that the outlet from the receiver has a liquid seal. Keep, if possible, the gage glass in the receiver about half full all the time. If there is no gage on the receiver, get one at the earliest opportunity, especially if you are new in the business. The moment that the liquid level gets below the outlet from the receiver some of the gas escapes into the liquid line which radically reduces the efficiency as well as the capacity of the system. Nothing but pure liquid should get into the expansion coils because it is the evaporation of the liquid that does the business.

KEEPING THE CHARGE PURE

TO KEEP the charge pure, use as little oil as possible and keep the air out of the system. Some of the largest plants in the country never use any oil except a small amount that drips on the rod in front of the stuffing-box, the same as used in many plants for steam rods with metallic packings. There has been no more trouble experienced with scoring or wear of the compressor cylinders in these plants than those where they souse the machine with oil. One thing must be remembered, that once a little oil gets into the system it stays there and works around the system all the time, necessitating but little additional oil to do the work. Ammonia itself is also slightly lubricating.

In many plants the oil that is drawn off from the oil traps is filtered and used over again. This is bad practice, and the better way is to use the old oil for the bearings and use new oil for the compressor. I can recall several cases where the operator got into trouble by using the filtered oil. Once the charge gets polluted with water from this cause, the system will not work properly until the water is gotten rid of, and this means taking the whole charge out and sending it to the manufacturer, or else installing a still on the premises, which is slow and tedious work.

Moisture also gets into the system with the air every time that this is drawn in for any reason. For this reason it is inadvisable to pump a vacuum on the system unless it is absolutely necessary. Care must also be taken not to run the compressor with the suction valve shut more than can be absolutely avoided, because it is almost a foregone conclusion that air will be drawn in at the stuffing-box sooner or later.

Before leaving the subject it might also be well to mention the blowing of the oil traps. This should be done regularly and symmetrically. Never allow the oil to accumulate in the traps until they are quite full and at the same time they should not be blown every time there is a thimble-full of oil in them because this will waste a lot of ammonia in a season's run. Keep track of the amount of oil that is used in each compressor and you will have a pretty good idea of how much there is in the traps.

AMMONIA LEAKS

THE GREATER PART of ammonia losses are due to leaks. For this reason the refrigerating plant operator should everlastingly be on the lookout for these. For locating them, other than those located under brine or water, there is nothing that beats the old sulphur stick. For leaks under brine or water use litmus paper or Nessler's solution, the use and making of which can be found in almost any book on the subject as well as ammonia manufacturers' catalogs. Tests should be made regularly every week or so of the entire system to catch any incipient leaks and get them stopped before they get too large. Remember that every ounce that is lost is so much money lost from the earnings of the plant.

EXPANSION AND CONDENSER COILS

CLEAN EXPANSION and condenser coils mean an increased efficiency and capacity of the entire system. Generally, the only thing that fouls the coils on the inside is oil, which is another reason for using scrupulous care in the quality and quantity of the oil used. The only way to get this out is to heat the coils either with steam, hot air, or hot ammonia gas, and obviously this has to be done in the off season when the plant is shut down. On the outside, condenser coils get covered with scale after they have been in operation for some time and direct expansion coils are always more or less covered with frost and ice.

On atmospheric condensers it is a simple matter to remove the scale and soft slush that forms with a properly shaped scraper. This should be shaped to fit the curvature of the pipe and have a knife edge, when the scale and slush will be scraped off by running this along the pipe. Very hard scale cannot be removed with this device, but it will get enough to pay for the

trouble incurred. Very hard scale must be removed with a hammer and a chisel with a curved edge to correspond with the circumference of the pipe. Some of the mechanical cleaners, manufactured by several concerns, also do the business rapidly and nicely.

Water pipes of double-pipe condensers can be cleaned with an ordinary flue brush if the accumulations in the pipes are soft. If there is any amount of hard scale, however, the only satisfactory remedy is a turbine cleaner, the same as used for water-tube boilers. This can be done, even when the condenser is in operation, by shutting off the water on one coil at a time and removing return bends. It is not necessary to shut off the ammonia.

Clean surfaces in the condenser mean a lower condenser pressure with the same quantity of water or less water for the same condenser pressure. In either case it means a reduced cost of operation. For this reason more attention should be given to this detail than is usually done.

Frost on direct expansion coils can be removed by scrapers, but it is an unsatisfactory job at the best. After this has been done a number of times there is quite a thick coating of ice on the coils, which, of course, reduces the capacity of the coils and in turn the suction pressure. This in turn means reduced capacity of the entire plant and increased cost of operation.

The best method is to connect a bypass connection from the discharge line to liquid line and compress hot gas into the coils. The gas as it condenses in the coils gives up heat to the frost on the coils which loosens up and can be removed easily and with dispatch. To clean any coil it is only necessary to shut off the liquid line at the receiver and the expansion valves on all the coils but the one that is to be cleaned. The expansion valve on this coil is opened wide and the suction valve is shut. The bypass from the discharge to the liquid line is then opened and the hot gas shot into the coil. If the pipes are of ample dimensions the frost will come off in a hurry.

As soon as the frost is off, shut the expansion valve, crack the suction valve off the seat very carefully to prevent slugs of liquid from escaping into the suction line and back to the compressor; shut off the bypass connection; open up the valve in the liquid line at the receiver again and set the expansion valves. Gradually open the suction valve on the coil that has been defrosted until frost begins to show on the coil; then the suction valve can be opened wide and the expansion valve set for normal operation.

Troubles with the Stuffing Box

The stuffing box will probably cause the beginner more worriment than any other part of the system. A large part of this is due to improper handling of the expansion valves. If the proper judgment is used in setting the expansion valves a lot of the stuffing-box troubles will be eliminated. If some valve is opened up too much, liquid will be carried back to the compressor and cause it to run cold, which in turn cools the rod and packing, the packing contracts and sometimes freezes, and to prevent leaks it must be drawn up very tight. Then if the valve is pinched off a little again, the excess supply of liquid stops, the machine warms up and with it the rod and packing and the first thing one knows there is a cloud of smoke rolling out of the stuffing-box.

When this happens, it generally takes considerable time to cool off the rod and packing and the new man in his anxiety to stop it will generally let the stuffing-box nuts out far more than is necessary and get the packing loosened up in the box. Furthermore, he is liable to rush back to the expansion valves and open them up a lot more than is necessary, in order to cool the machine off. The result is that the machine is suddenly cooled off again and with the packing excessively loose in the stuffing-box it is ruined in a short time and fails to hold tight with the best of care.

If at any time the stuffing-box or rather the rod is found to be getting hot, do not be in too much of a hurry about backing it off. Loosen up the nuts until they are a little more than finger tight and let it run that way for a while. Remember it takes time to cool the rod after it gets hot and also if the machine is running warm the rod will run quite warm also. After the nuts are fairly loose slack off on them about $\frac{1}{8}$ turn at a time until it stops heating. Let it run for some time between each time the nuts are slacked off to determine whether the rod is cooling off or getting hotter.

If it is found that the stuffing-box is leaking because the machine is getting cold, it is bad practice to draw up on the nuts after they are fairly tight to stop the leak. It is far better to shut off the liquid at the receiver for a short time and let the machine warm up. If the machine gets very cold, the packing gets so hard that it is impossible to draw it tight enough to stop the leak unless an excessive tension is put on the nuts. This is bad for the rod as well as the packing.

Managing Expansion Valves

Management of the expansion valves is what will demonstrate the engineer's ability, knowledge of operating principles and good judgment. It is here that the difference between the real engineer and the mediocre man is most prominent. No hard and fast rules can be laid down for the setting of any expansion valve as each valve and coil requires individual treatment. A few general principles, however, that are applicable to all conditions, can be set forth as a guide for general procedure.

The rate of evaporation of any coil, which in turn determines the amount of valve opening, depends on the coil surface, the temperature difference between the boiling ammonia in the coil and the room or brine temperature, and the cleanliness of the coils, inside and outside. A 1000-ft. coil of $1\frac{1}{4}$-in. pipe, for example, will not evaporate as much liquid as a 1000-ft. coil of 2-in. pipe on account of the much smaller evaporating surface of the $1\frac{1}{4}$-in. pipe. All other conditions remaining the same, a 1000-ft. coil will only evaporate about half as much liquid as 2000 ft. coil of the same size pipe. This is quite evident as the surface of the 1000-ft. coil is only half of the 2000-ft. coil. A coil located in a room where the temperature difference between the boiling ammonia and the room is only half that of the temperature difference in another room will only evaporate

about half the ammonia that the coil in the warmer room will do, both coils being of identically the same dimensions. A coil badly fouled with oil on the inside and heavily frosted on the outside will not evaporate as much liquid as a clean coil by far, the difference depending on the extent the oil is accumulated on the inside and frost on the outside.

From the foregoing it is readily seen that a short coil, loaded with oil and heavily frosted, located in a cold room where the temperature difference between the ammonia and room is small, will evaporate but little liquid, consequently in this case the expansion valve can be opened but little; just about enough so that the liquid can be heard passing through when the ear is held close to the valve will generally be all that it can take.

On the other hand, a long coil of large pipe, clean and located in a room of high temperature where the temperature difference is large, will evaporate a large quantity of liquid. In this case the expansion valve can be opened a large amount, possibly as much as a whole turn in some cases. Generally, a quarter to half a turn is about as much as the average expansion valve is opened.

To judge the action of the individual coils watch the suction pressure, the temperature of the machine, the frost on the coils (where these are located in the open as in direct-expansion work), and the frost line on the suction and expansion valves. The frost line on the suction valves is all the indication required on a brine or ice tank. Adjust the expansion valves so that the frost line on each suction valve comes to the same point and then pinch back or open up on all the valves until the temperature of the machine is right. In direct expansion work where the rooms are below freezing the entire coils will remain frosted no matter if it is working or not and in this case one will have to use considerable judgment when setting the valves for the first time. The length of each individual coil, the temperature difference between the ammonia and the room and the amount of frost on the coil must all be taken into consideration. Also if some of the coils are made up of different sized pipe, this must be allowed for. After the first setting each individual valve will have to be experimented with until the point is reached where the maximum suction pressure is obtained with the compressor running at the proper temperature.—Refrigerating World.

COST OF AMMONIA per ton of ice is given by J. E. Vickers, of Neosha, Kans., as follows in Refrigeration:

For 1913, 5.2 cents; for 1914, 2.3 cents; for 1915, 8.8 cents; for 1916, 2.3 cents.

The plant is 18-ton capacity, operating 6 to 8 mo. a year and having an 1100-ton storage in connection with it. In 1915, the cost was high because of the addition of 3500 ft. of 2-in. direct expansion coils in the large storage, and 750 ft. of 1¼-in. coils in the daily storage. Also a double pipe condenser stand, 18 ft. long by 12 pipes high, all of which took extra ammonia to charge.

Economy of ammonia was secured by watching for small leaks. The large ones make their presence known without watching for them.

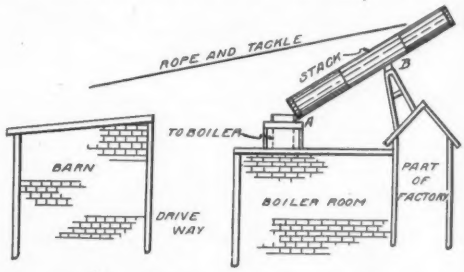
Raising a Steel Stack

BY H. A. JAHNKE

DUE to rusted joints and loosened guide lines, a 40-ft. stack having a diameter of 30 in. and employed in connection with a factory power plant, recently fell over. Repairs had to be made, and as the plant could not be shut down for any length of time, it was necessary to do this work with the least possible delay.

The worst sections, of which there were three, were removed and the remaining sections straightened out and although the stack was now reduced in height by 12 ft., the draft provided was sufficient. Instead of rivets, 5/16-in. stove bolts were employed in connecting these sections.

Adjoining the power house was a section of the factory building while directly across an alley way was a barn. The stack was raised onto the roof of the boiler house by means of ropes and timbers against the building wall. One end of it was then, as shown in the accompanying illustration, placed next to the stack thimble while the opposite end was placed against a 6-ft. horse resting on the roof of the factory building as at B. By



MANNER IN WHICH STACK WAS RAISED IN PLACE

means of a rope and tackle handled by a number of men on the roof of the barn with others steadying it by the four guide lines, it was finally brought into place.

But 8 hr. were required to repair and raise the stack, and according to all appearances, it will give many more months of service.

AN INTERESTING DEMONSTRATION of the use of water transportation was given on Aug. 14 in the Ohio river, by an artificial flood created by opening the pools along the Big Sandy, the Kanawha and the upper Ohio rivers, and allowing surplus water to run out. This raised the level of the river about 3 ft. at a time when there was not sufficient depth for boats drawing more than a couple of feet, so that a fleet of barges carrying 13,000 tons of coal was sent down to Cincinnati. To ship this by railroad would have required 350 cars, which indicates the assistance to transportation which may be effected by this means.

TO MAKE food conservation a success, everybody must line up. And food conservation must be made a success if we are to win our war for the freedom of democracies. It is a big volunteer job; every man to volunteer and to act on his honor. The essentials are—one wheatless meal a day—meat once a day—eat what you need, but no more—no food wasted. It's your game for home and country. Volunteer, keep your own score and play fair.

Draft and Smoke Abatement

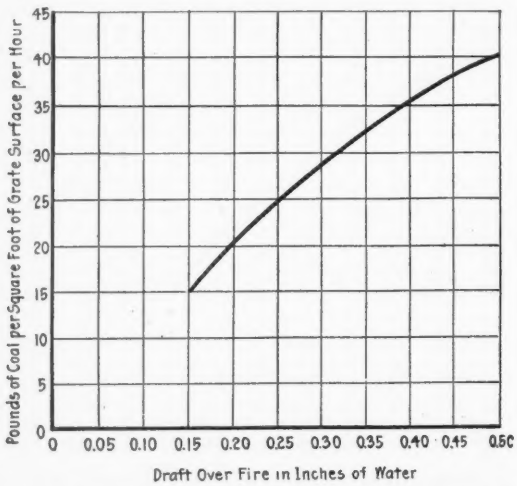
How Much Coal Can You Burn and Not Make Smoke?

FOR hand-fired units, Osborne Monnett places the limit rate for successful smokeless combustion at 28 lb. of coal per square foot of grate surface per hour.

As stated before the Engineers' Society of Western Pennsylvania, he has found that the most important item in smoke abatement is Draft. And the curve herewith shows the amount needed above the fire for various rates of combustion.

The curve roughly shows 0.1 in. of water needed per 1 lb. coal per hour per square foot of grate, the draft needed increasing slightly above this ratio at the higher rates of burning.

Draft lost in the boiler setting will be 50 to 65 per cent of that at the base of the stack so that the stack must furnish 2 to 2⅓ times the draft needed above the fire. And Mr. Monnett advises the Stirling formula for determining the height of stack needed.



DRAFT NEEDED TO SECURE SMOKELESS COMBUSTION

Tests in Chicago showed that the standard Hartford setting works better than the flush-front Dutch oven type for high volatile coals, as the heat from the brick roof tends to produce too rapid distillation of the volatile matter causing dense smoke, and direct radiation from the grate into the boiler helps to increase capacity.

While this may be true of a few light oils, it certainly is not for the majority of the California heavy crudes, and especially not when Mexican crudes are considered, as these oils are generally high in ash which invariably collects on the heating surfaces, forming a crust which greatly reduces the heat transmission, resulting in a high flue gas temperature and greatly reduced economy. In a majority of plants, it will pay to dust the boilers at least once a day, the ash formation being very difficult to remove if allowed to collect for some time. The writer has seen as high as 50 lb. of ash removed from one boiler after a 6 weeks run with no dusting, and from the appearance of the tube bank it was likely another 25 lb. remained cemented to the tubes in portions of the boiler not accessible to the steam lance.

Uses for Ejectors

THE most common use for ejectors is the elevating of water with steam as power, but in the various types they can be made to perform economically under a very wide range of conditions, some of which are cited by the Penberthy Injector Co. as follows:

With steam as the operating medium, the ejector will elevate liquids that are of greater specific gravity than water; will handle liquids of less specific gravity (gasoline, for instance), in fact, any liquids the character and temperature of which are such that it will condense the steam and mix with it; will create a partial vacuum for such work as priming centrifugal pumps; will exhaust air or gas from pipes or tanks.

With water as power, the most commonly known use is that of cellar drainer, for taking seepage from basements, etc. This type is made to operate automatically by use of float mechanism.

Water pressure ejectors, or hydraulic ejectors, as they are commonly called, are made in a variety of types from the smallest used to empty washtubs, by attaching to the water faucet up through those used to exhaust air and gases, to move and elevate water and other liquids, to create partial vacuums, to the large sizes used by public service corporations and municipalities to attach to the fire hydrant and pump out basements, trenches, etc.

With air as power, it is capable of exhausting air or gases and for creating partial vacuums, as in the priming of centrifugal pumps, etc., but can only be made to handle liquids under certain conditions through the medium of auxiliary tanks, or submergence in the liquid to be elevated.

It is well to remember that there are two commonly used types: first, that using steam as power for handling water; second: that using water under pressure as power, for handling water. Practically all others are variations of these two, and they can be specially constructed to give highly efficient service under the conditions for which they are designed.

The steam ejector is extensively used for handling acid and alkali solutions, the stock ejector being very efficient against the milder solutions containing acid; it is also made of special anti-acid compositions which will oppose the action of acids as far as it is possible for copper alloy to do so, and for the alkali solution it is made wholly of iron.

The extremely low first cost of this little device, its simplicity of construction, with no moving parts and nothing to get out of order, its efficiency when properly used, all recommend its use wherever practical.

THE HARVEY PROCESS for hardening armor plate was invented in 1888; smokeless powder a few years earlier; the wax phonographic record, which made the phonograph a practical proposition, came out about the same time; Westinghouse's quick-acting brake, which only failed to be considered a pioneer invention of the first order by a five to four vote of the Supreme Court, was another notable addition to the decade; the transparent film, which foreshadowed the moving picture; and the pneumatic tire, were prominent contributions of those pregnant years.—The Valve World.

Waiting for Speed to Catch Up

How the Water Wheel Governor Stops Short of Regaining Normal Speed and Why it Must. By G. H. Kimball

RICHARDS, the oiler, was fortunate in securing a position where his chief was interested in his advancement and being ambitious to get ahead in the power plant field, he put many questions to his superior and received such detailed information that he was advancing well into the technicalities of construction and operation. After an evening of pondering upon the subject, he came to his friend with the question: "How are water wheels regulated?"

Chief Wallace answered: "It is a long step from the first form of governor which I saw on a wheel to the modern quick-acting machine. The older governors open the gates by a ratchet arrangement; but when a load equal to ½ the capacity of the wheel is thrown on or off suddenly, the gates must be opened quickly to hold the speed anywhere near normal, and there is more change than there would be in a steam engine, yet the regulation is very good with the new form of governor.

"Almost all good governors use oil or water under pressure to move the parts, as it is necessary to have powerful machinery to work the heavy gates in the wheel case.

"At the Glendale plant the governor used a belt to move the gates and the power was controlled by water pressure supplied at about 40 lb. per sq. in. You can see it was like this sketch, which shows the principal parts of the governor. The gear, *H*, on the main shaft, *S*, was connected to a larger gear on another shaft that carried the sheaves with the ropes that went down to the wheel gate shaft.

"Pulley *P* was turned by a belt from the jack shaft and turned the disks, *C* and *I*, in opposite directions by means of the gears, *J J*. Inside clutch shoes *K* were pressed against the inside of the disks by the links, *L*, and the clutch, *C*, would turn when the rod, *D*, inside of the shaft, *S*, would be moved in the direction of the arrow by the lever, *B*, which would be pushed out by the piston inside of the cylinder, *M*. In the same way, when the piston acted in the opposite direction, the clutch in the disk, *I*, would turn, one closing the gates and one opening them. The links, *L*, were adjustable in length so that the movement of the rod, *D*, would allow one clutch to release before the other would grip the disk.

"Inside of the pulley, *P*, were weights similar to those that we see in some governor wheels in steam engines, and these operated the valve, *V*, in valve seat *A*, which admitted the water to either end of cylinder *M*, by means of rod *G*.

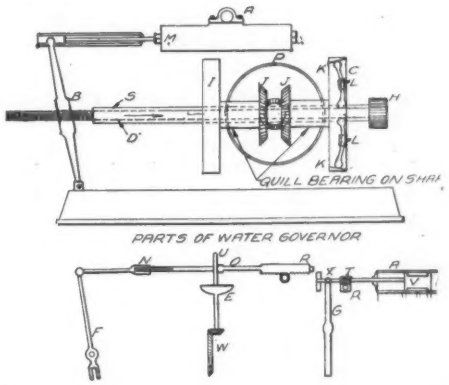
"On the valve stem was the small gear, *T*, meshing with rack *R*, which, being moved by the lever, *F*, from a pin on the side of lever *B*, would turn the valve stem and change the lead of the valve.

"Thus, when the change in speed caused a movement of the governor in either direction, the valve would be closed to shut the water from the piston before the speed reached the normal point again. The lateral movement of shaft *O* would throw the little wheel, *U*, off center in moving disk *E*, which was turned by gearing *W* from clutch disk *I*, and as wheel *U* was pushed from the center point, it would turn, and the screw working in nut *N* would set it back to the center again. This last mentioned part of the governor is called the relay and without it the machine could not control the speed of the wheels."

"Why is that?" said Richards. "I should think that all the governor would have to do would be to stop closing the gates when the speed had come to the right point, for the weights in wheel *P* would move as the speed changed."

"That is one peculiarity about water wheel regulation," said Wallace, "for it is necessary that the governor should not keep on opening the gates until the speed has come to normal, but that it should open them a certain amount, and then wait for the return of the speed which will come, if no more load is added or removed, and without the relay attachment this cannot be done."

"But what causes the wheels to act like that?" was the next query.



PARTS AND ARRANGEMENT OF WATER WHEEL GOVERNOR

"It is because the water is incompressible and a large body of it has inertia, so that it takes time to change its speed or rate of moving, the same as a heavy flywheel. When the gate opening increases to increase the flow, the water in the penstock takes a little time to speed up, and the governor must wait for this, or it will open the gate too far and overspeed the wheel. The opposite action takes place when the governor acts to close gate. Steam does not act that way, for it is compressible and has little inertia.

"There are some other parts to the governor that I have not shown; but they would not tell any more of its action, so, to avoid confusion, I left them out," said the engineer.

To frost brasswork and give it an ornamental finish, boil the article in caustic potash, rinse in water, and dip in nitric acid until all oxide is removed; then wash quickly, dry in boxwood sawdust, and lacquer while warm.—Mechanical World.

Production of gasoline from natural gas increased to 38,848,144 gal. in 1916, a gain of 59 per cent over that of 1915, and the price averaged 14 cents a gallon in 1916 as against 6 cents in 1915, making a gain of 180 per cent in value of the gasoline produced.

LETTERS DIRECT FROM THE PLANT

Cash Paid For Ideas Accepted. Sketches Desirable.
We Make The Drawings

Some Power Plant Repairs

A HOISTING engine had broken its intermediate shaft and as we were located where it was impossible to get a new one quickly, I was compelled to make a new one. The shaft, as will be seen from the accompanying sketch, was much larger at the center than at the ends. To have made the shaft of one solid piece there was required a piece of stock 4½ in. diameter by about 8 ft. long, but on investigation we discovered a piece of 3 15/16-in. shafting of the required length, but nothing was to be found as large as 4½ in. in diameter. Both ends of the shaft were 3 15/16-in. in diameter, so we decided to use the 3 15/16-in. shafting and build up the center. For this we used a piece of 4-in. extra heavy steel pipe which was bored and shrunk on the shaft, and turned in a lathe. The keyway was cut a little deeper, so as to give the key sufficient bearing in the shaft. The job was finished much quicker than if we had made a new shaft of one solid piece, and was as good, if not better than the solid shaft.

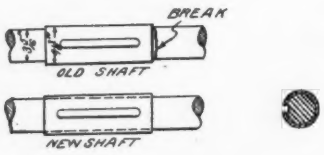


FIG. 1. BROKEN SHAFT AND METHOD OF REPAIR

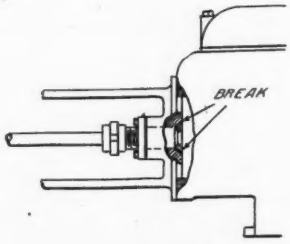


FIG. 2. EMERGENCY REPAIR TO PUMP STUFFING BOX

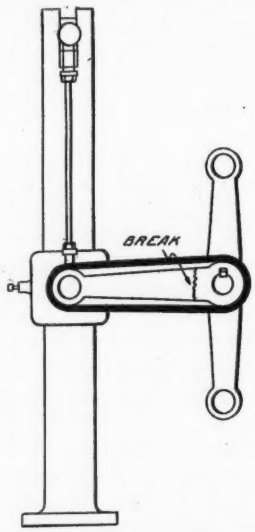


FIG. 3. IRON BAND USED TO REPAIR GOVERNOR ARM

The bottom of the stuffing box of a water pump was broken out and allowed the packing to be drawn into the cylinder. A temporary repair was made by reversing the gland and threading the round portion to receive a cap and form a stuffing box outside, as shown by the accompanying illustration. The old gland was then replaced with the face of the flange to the cylinder with a gasket between to make a tight joint. This worked nicely until we were able to make the proper repairs.

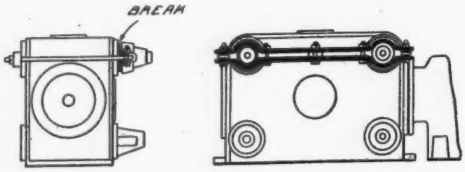


FIG. 4. TEMPORARY REPAIR FOR CORLISS VALVE GEAR

A broken governor-arm was repaired as shown in the accompanying illustration. It was repaired in a very short time by making a band of a flat piece of iron to go around the arm, and slightly smaller to allow for shrinkage. The band when shrunk on drew the arm up together tightly and securely.

A small Corliss engine had broken both steam bonnets, and a temporary repair was accomplished as shown in Fig. 4. Two pieces of flat iron were prepared by the blacksmith, to fit around the loose ends of the bonnets, and these were held securely in place with five bolts. Two eyebolts were then made and placed at each end of the cylinder; one end of these bolts was attached to the clamps for the bonnets and the other end was passed through a heavy piece of flat steel, which served as a clamp and was placed over the valve caps, lengthwise with the cylinder. The nuts on the eye-bolts were then screwed up and bonnets were drawn up into their place and held securely in their proper positions. This did not make a very neat looking affair, but it served the purpose and enabled us to use the engine until new parts were received and installed.

E. S. RAY.

Effect of a Crooked Exhaust Line on a Corliss Engine

SOME TIME AGO the writer took charge of a steam plant containing several old Corliss engines. One of these engines, a Cooper-Corliss, with 22-in. bore, 42-in. stroke, and making 70 r.p.m., seemed to be overloaded. It exhausted into a Deane jet-condenser which maintained a 24-in. vacuum.

An indicator was applied to the engine and cards taken. The cards were typical of this kind of engine, running at this speed, and showed the boiler pressure falling off to the point of cutoff and loss of power due to restricted exhaust-port area. The cards also showed that not enough power was being realized from the vacuum. At the beginning of the stroke or where the condenser took hold of it, only one pound was realized, at the middle of the stroke, 6 lb., and at the heel of the exhaust 7 lb. After a careful study of the cards it was decided to look farther than the ports to see what was choking back the exhaust.

The condenser is located on the same floor as the engine, the steam inlet being about 8 ft. to the side, 2 ft. back of, and 6 ft. above the steam outlet of the engine. An 8-in. exhaust pipe ran from the engine to the condenser. For some unknown reason this line was exceedingly crooked, two 45-deg. els, six 90-deg. els, and about 50 ft. of 8-in. pipe being used in its construction. It was decided that this line was choking back the exhaust and a new line was installed which used only one 45-deg. el and two 90-deg. els with 20 ft. of pipe.

After this change, the engine immediately showed an improvement in handling its load. Cards were again taken and these showed that 2, 10 and 11 lb. respectively were realized from the vacuum instead of the previous 1, 6 and 7 lb.

This change effected a very handsome saving in steam which soon paid the expense incurred in making the change; however, it was figured that the salvage from the old line more than paid this expense. R. G. H.

White Metal Piston Packing Rings

THE CAST-IRON packing rings of the steam piston of a 12 by 10 by 18-in. boiler feed pump had become worn, and were a poor fit, both in the cylinder and on the piston, the pump being one of the main supply units. It nearly always was in use when full boiler power was

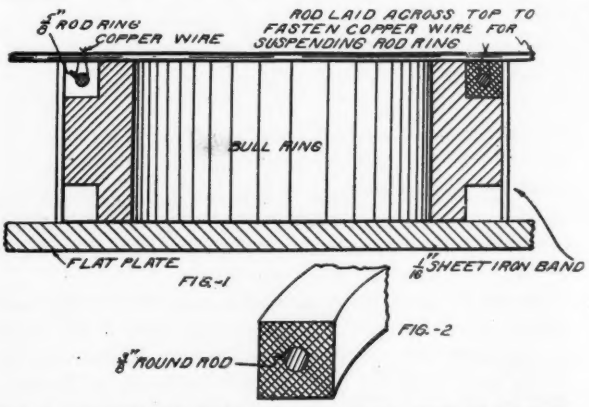


FIG. 1. SECTION OF BULL RING AND MOLD USED IN CASTING PISTON RINGS

FIG. 2. SECTION OF WHITE-METAL PACKING RINGS WITH REINFORCING ROD

called for at peak loads. It was therefore necessary to make any needed repairs in quick time—that is to say, we had no time to waste waiting for new rings to be made and fitted. We therefore decided to experiment with white-metal packing rings, as we had read of some being successfully used.

We, however, changed the scheme of making them somewhat, as will be noted by anyone who has made white metal packing rings for either steam or water cylinders. The construction of this steam piston was the built-up type, fitted with one junk or bull ring, and 2 split iron packing rings, the bull ring being solid.

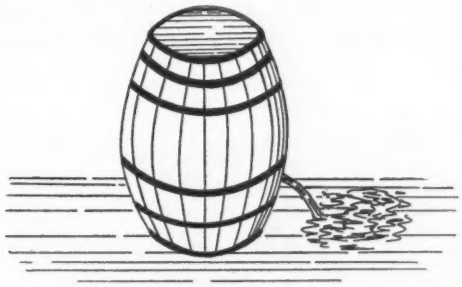
The bull ring, surrounded with a sheet-iron band, as shown in the sketch, was used for a mold; a strengthening of 3/8-in. round soft rod was made of the correct diameter; this was placed or suspended, as shown, so as to be cast into the center of the white metal packing ring. A sectional end view of the completed ring is shown in Fig. 2. This ring of steel cast into the center of the babbit, gives them additional strength.

A set of these rings was cast and dressed up with a file and scraper, and installed; they have been giving good satisfaction, and though they cannot be considered as the best for use in a steam cylinder, they are excellent to tide a fellow over a break-down when he finds a broken cast-iron packing ring, and no spare on hand. There is no machine work attached to making them, so the kink may come in handy where no lathes are available. C. H. W.

Plug Those Leaks*

WHY AREN'T barrels of oil allowed to leak in and around a plant as pictured here? Why are we so careful to keep the barrel hoops tight? Simply because it is undesirable to have oil on the floor? Or because of the value of the oil? Of course, there's no reason why those questions should be answered here. We all know the answers. The reason why I use this illustration is because I want to point out more forcibly the value of little things.

Let us assume that there is a little round hole in a barrel of oil in your storeroom and that unless plugged the oil will all leak out in a day. If a plug that would fit that hole and stop the leak would cost a dime you would surely invest a dime and save, say, $5 or $10, depending upon the quality of the oil. You would consider the purchase of the plug a good investment.



A VISIBLE WASTE

Now, the peculiar thing about us is that we gladly buy preventives when we see that the preventive is actually doing something. Oil is a thing that can be seen with the naked eye. But when it comes to purchasing something for the elimination of friction losses, we hem and haw. Friction cannot be seen. It is invisible. We therefore get along with the old plain bearings in important places where ball bearings would be better.

*Copyright, 1917, by W. F. Schraphorst.

We refuse to spend more for a better lubricant. We rebabbit bearings only after they give so much trouble that the wheels cannot be kept going, and we use inferior babbit.

There is one place where these leaks can be observed if we will but go and look—out in the coal yard. The coal pile is bound to suffer. But do we go out there often enough and take a look? I fear we don't. The millwright doesn't worry much about power. As long as he keeps his end of the job a-running he is generally satisfied.

It is evident, therefore, that the man higher up must take an active interest in the power end of the plant. We should spend just a little money for these "plugs," such as ball bearings, better lubricating oil, greater bearing accuracy and shafting alinement, etc. In this "etc." I would include a good belt treatment for the purpose of stopping belt slip, for belt slip is a decidedly wasteful "leak." And proper belt treatment is a mighty good "plug."

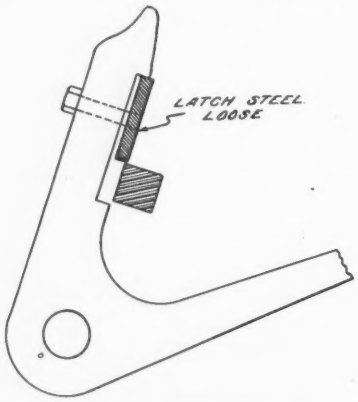
Shaft slip is a kind of slip you seldom read about. As a matter of fact I don't know if "shaft slip" is the proper name for it, but I can't think of anything better—it is the slip that takes place between the pulley and shaft when the pulley gets loose. This frequently happens with pulleys that are affected with atmospheric variation. Power loss due to shaft slip is just as serious as that due to belt slip. The cost is the same for each per cent of slip.

For example, if a given shaft didn't rotate at all, and if the pulley rotated on it at normal speed with the engine or motor laboring at full load, it is evident that all of the power would be lost in friction between the pulley and shaft. The slip would be 100 per cent. The power loss, also, would be 100 per cent. Hence it can be proved that the same rule holds here as with belt slip—that each per cent of slip means one per cent of the coal pile.

W. F. SCHAPHORST.

Engine Troubles

A CORLISS ENGINE started to race one day, making it necessary to shut down at once. Upon our examining everything connected with the regulating mechanism,



LOOSE LATCH STEEL

nothing was found which could cause the trouble. The governor bearings received a good oiling, and the engine started, but still raced. Then the valve gear was examined, when it was found that the latch steel at the head end valve gear got loose and was in the position shown in the illustration, which did not allow the valve to unhook, causing the engine to take steam full stroke. In this wild goose chase the engineer did not notice this. The valve gear on this engine is of the oval arm type.

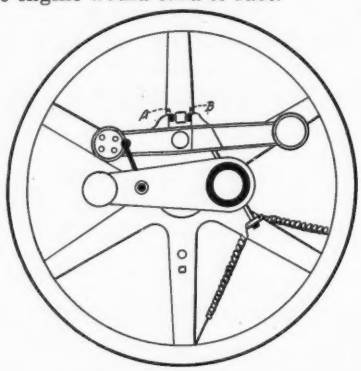
This same engine started to race again a short time after, when a dry bearing was found on the shaft on which the belt pulley and gear driving the vertical governor spindle was, making the belt slip, in turn causing the governor to run slow so the valves would not unhook, giving the engine steam full stroke. When the oil hole and oil groove were cleaned and shaft oiled well, there was no more racing. The engine is not equipped with any safety device.

H. A. JAHNKE.

Peculiar Governor Trouble

A FEW YEARS AGO, I assumed charge of a plant consisting of one 22 and 48 by 72-in. Corliss engine and one 19 by 16-in. Ball engine generating set, rated at 150 kw., 230 v.

I was told at that time that the latter set was too small for the load it was required to carry, which appeared to be true. To make certain, however, I took some indicator cards from this engine and discovered it to be developing but 122 hp., considerably less than its rating. I also found that, in starting up and before the load was put on, the throttle could not be opened wide because the engine would tend to race.



FLYWHEEL GOVERNOR WITH STOPS TOO LONG FOR SATISFACTORY OPERATION

From these symptoms, I concluded something must be wrong with the governor, which I at once inspected and found that some former engineer had made both no-load and overload stops too long.

From the accompanying sketch the effect of this may readily be understood. With no-load stop A too long, the governor cannot go out sufficiently to shorten the travel and hold the engine with no load; while with the overload stop B too long, the governor would come to a stop before full valve could be realized.

Shortening both stops allowed the engine not only to run with no load, but also to carry considerably more load than heretofore.

A. C. WALDRON.

Stoker Installation Costs

IT WAS with considerable interest that I read the article entitled, Cost of a Modern Underfeed Stoker Installation, by John D. Morgan, published on page 701 of the Sept. 1 issue of Power Plant Engineering,

and believing that others may be not only interested but benefited by additional data along these lines, I submit the following:

When originally installed, the plant under consideration consisted of 4 return tubular boilers, each rated at 150 hp., and hand fired. The boiler room personnel was made up of two firemen and one coal passer who were on duty 11 hr. each day. The coal used was a good grade of New River, averaging 13,200 B.t.u. on test; we were evaporating 8.3 lb. of water per pound of coal as fired.

We felt, however, as if we might be able to reduce our operating costs, and therefore decided to install an underfeed stoker equipment on three of the boilers with fan and engine of sufficient capacity to care for an additional unit, should it be decided to install such at some future date. The engine was of the vertical self-oiling type with a 6 by 7-in. cylinder and the fan was 3 ft. in diameter with a capacity of 10,100 cu. ft. of air per minute against a pressure of 2 oz.

The cost of this part of the equipment was.....	$2600.00
Galvanized iron air dust made up of No. 12 gage material with all joints soldered and riveted	100.00
Labor to make necessary setting changes.....	210.80
Labor of two stone cutters.....	8.00
Pipe and fittings for engine, with labor.....	65.82
Brick and cement.....	218.70
Sand and stone for concrete around air duct...	20.00
Lumber for forms.....	28.60
Belt for fan and engine.....	41.28
Total cost	3292.90
Cost per boiler horsepower.....	7.31

As a result of this change, we are able to run with but one fireman; we can carry our loads with the same amount of fuel, but made up of a mixture of 33 per cent of No. 3 buckwheat and 67 per cent of the grade heretofore employed; the unit evaporation was increased to 8.42.

Careful tests made to determine the amount of steam necessary to operate the engine, fan and stokers indicate an average of from 2 to 3 per cent of the boiler output, all of which is utilized. RECEIVER.

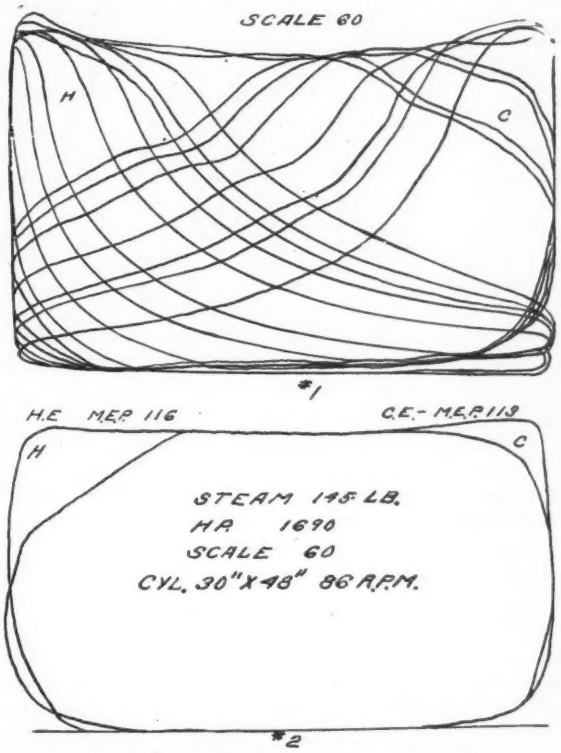
Length of Cutoff on Corliss Engines

IN THE July 15 issue, R. A. Cultra makes the statement that the average length of cutoff on a double-eccentric Corliss engine is about ½ stroke, which he claims is the general limit of the governor action. Cutoff at ½ stroke or thereabouts is probably the most economical in the double-eccentric engine, but that point is by no means the limit.

In the Aug. 15 issue in the last paragraph on page 668, Mr. Wakeman says: "The object sought in adding another eccentric is not to increase the power as it is not increased by this operation, but to extend the limit of automatic cutoff to ¾ stroke, and it secures this desirable action for a heavier loaded engine." It appears to me that this statement contradicts itself because extending the vailable point of cutoff will increase the available power of the engine. The point of cutoff in a Corliss engine, other things being equal, determines the mean-effective pressure, and therefore the horsepower developed by the engine; adding another eccentric is done for the purpose of securing a later cutoff and higher mean effective pressure, which in turn increases the available power of the engine, making it possible to add more load.

With cutoff occurring within the range of the single eccentric or not later than about 7/16 stroke (the limit is ½ stroke), little if any advantage can be gained by adding the second eccentric. The second eccentric does, however, perform a very essential function where it is desired to load the engine to the point where cutoff must be later than ½ stroke or the maximum limit of the single eccentric to get mean effective pressure great enough to maintain the speed and carry the load.

Several years ago, the writer had considerable experience with a 30 by 48-in. double-eccentric Wisconsin Corliss engine used for driving a roll train in a tube mill. In this work, the load was very intermittent and ranged from practically no load to 175 per cent of rated load within a few revolutions. In looking over a number of old indicator cards taken from this engine, I



INDICATOR CARDS TAKEN FROM CORLISS ROLLING MILL ENGINE

found two which bear directly on the subject of late cutoff, and which I believe will be interesting at this time. Card 1 was taken as the load increased, and the governor moved the cams to get later cutoff to meet the increasing load. This shows the action of the governor in retarding the point of cutoff from friction load to full load. In taking this diagram, the indicator pencil was pressed against the paper during 8 or 10 revolutions. The head end diagram was taken when one tube went through, and the crank end was taken when the next one went through. This, to some extent, accounts for the difference between the two ends. In the head end diagram, the latest cutoff occurs at about 13/16 stroke, while the friction load cutoff is very early,

being hardly more than the lead. It is also interesting to note that the exhaust and compression lines on the head end are almost exactly the same at the various loads except that when the load dropped off quickly and the governor assumed its highest plane of revolution which prevented the valves from hooking up, carrying the exhaust line below the atmospheric line, forming a negative loop for about two revolutions.

The variations of the point of cutoff do not appear extended over as wide a range of load on the crank end, as the load conditions were probably a little different at the instant the crank end was taken on the next swing of the load; but they show the increase or lengthening of point of cutoff which regulates the mean effective pressure, and thereby the power of the engine.

From the crank end, it may be observed that the governor did not seem to be changing the point of cutoff at a uniform rate, as the expansion lines are not spaced the same distance apart but are nearly in pairs, indicating that the governor travel was less between the second and third revolutions than either between the first and second or third and fourth. This may have been caused by the governor hunting, or by the ropes jumping. This difference is not so marked on the head end. The flywheel was rather light for this class of work, and the mill was driven by nineteen 2-in. ropes on the English or multiple-rope system.

Another point which is of interest in these cards is the quick release at the end of the stroke, which is shown more clearly in Card 2, taken at the moment of maximum load. In this card, the head-end diagram is almost a rectangle rounded only at the release, exhaust and compression corners. The straight steam line indicates clearly the absence of wire-drawing, which might be expected with the late cutoff. On this card the mean effective pressure is 116 lb. on the head end, and 113 lb. on the crank end, averaging 114.5 lb. The speed was 86 r.p.m. and the indicated horsepower about 1690. This engine was rated at 950 hp. at 150 lb. steam pressure.

The cards were taken when the valve setting was being checked up and represent clearly the action of the double eccentric feature as applied to the Corliss engine, and show conclusively that perfect steam control can be used from the double eccentric engine with cutoff later than ¾ stroke. From approximate tests made, I found that the engine was not as economical when carrying a load that required this extremely late cutoff as when the cutoff averaged from ½ to ⅝ stroke. I consider both diagrams as nearly correct as it is possible to get them under the varying load conditions, and the engine ran as well as could be expected under these intermittent load conditions. Another feature of this particular engine which helped to give this good card was that the exhaust valves were double ported, and set in the head in such a manner that the clearance was small. The steam valves were also double ported, and set close to the cylinder with short ports. The main steam line was about 100 ft. long from the boilers, and supplied other engines. There was a receiver-separator placed below the engine-room floor; the main came through the tunnel, and about 25 ft. of pipe connected the receiver to the throttle through a goose-neck bend.

J. C. Hawkins.

Breaking in a New Engineer

In breaking in a new engineer recently, the writer used the following outline in changing from one horizontal Curtis turbine to one of the same manufacture, but of a different design. Both machines operate condensing.

Condenser: Leblanc jet. Circulating and air pumps connected to same shaft. Speed, 1800 r.p.m. Auxiliary water primer. Turn on steam seals, main unit. Close vacuum breaker. Open turbo exhaust. See that traps to exhaust and steam lines are working properly. Examine oil level in all bearings. Turn on water seal to glands and automatic vacuum breaker. Start and bring turbo to speed. Open auxiliary priming valve to air pump until 10 or 12-in. vacuum shows on gage. Close primer and open main priming valve to air pump. Open injection valve. After vacuum is gotten on condenser, it is necessary to adjust main priming valve so as to hold a predetermined vacuum on air pump. Look over condenser.

Turbine: Horizontal Curtis, 3600 r.p.m. Fill and open oil cup to spindle of inertia governor. Clean oil screens. Turn on bearing water. Open throttle until machine starts to turn over. Examine oil rings and see that sufficient bearing water is flowing. Gradually bring turbine to speed and see that there is sufficient oil pressure on each bearing.

Switchboard. Standard G. E. Close exciter switch. Raise exciter voltage on alternator field (in this case) 118 v. Insert synchronizing plugs. By using remote speed control machines are brought to synchronism. Indicated by synchroscope. Close main switch on incoming machine. Pull synchronizing plugs. Shift load to new machine. At this point it is advisable to examine condenser and turbine and if everything is working satisfactorily, adjust rheostats in alternator fields and open main switch to outgoing machine.

In shutting outgoing turbine, trip machine, close throttle, open vacuum breaker, shut down condenser pumps, close all seals, priming valve and injection valve. Open all drains and close valve at main steam header.

In breaking in a new man, it is good practice to let him perform all of the operations when starting up or shutting down; at the same time explain the "why." In one instance an operator in a central station found it necessary to shut down. As he had been working under a second engineer for something like 3 mo., he had never been allowed to put on a machine. The power was off for about an hour until a man that was broken in came on the job. Had this man been taken in hand as he should have been, when the time came for him to operate he would have experienced no trouble.

Jack L. Ball.

Men who strive to build themselves up by tearing down the work of their fellows generally succeed in undermining their own foundations and falling into the common ruin. The secret of success is co-operative effort and giving to everyone credit for that which is his due.—Machinery.

Questions Answered and For Answer

Expert Help When In Trouble. If You Want Quick Answer Enclose a Stamp

Two-Phase Motor Connections

WILL YOU kindly publish a diagram of connections for a 10-hp. Westinghouse 2-phase, 440-v., alternating-current motor? The machine in question has 4 leads, and the starting compensator employed with it is also of Westinghouse make and has 12 leads. Can you tell me which of these leads to tie together?

SUBSCRIBER.

A. Referring to the sketch shown herewith, it will be noticed that each of the 2 auto transformers has 5 taps—A_1, A_2, A_3, A_4 and A_5 and B_1, B_2, B_3, B_4 and B_5.

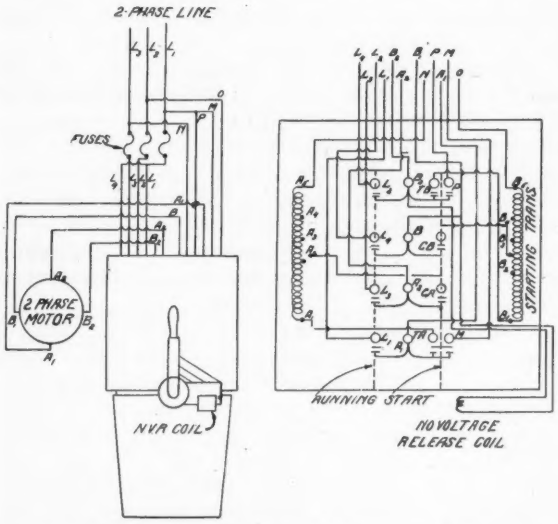


DIAGRAM OF CONNECTIONS FOR 2-PHASE ALTERNATING-CURRENT MOTOR

Taps A_1, A_3 and A_5 and B_1, B_3 and B_5 are employed in standard connections, giving 65 per cent of line voltage in starting. If this should prove too high, substitute top A_2 for tap A_3, and B_2 for B_3; if too low, substitute instead, A_4 and B_4 respectively.

Have all idle taps well taped before replacing cover.

W. P.

Calculating Horsepower of Gasoline Engines

HOW MAY I calculate the horsepower of a gasoline engine, such calculation to be based upon the size of bore, piston travel, etc.? J. E. K.

A. There are three methods in common use. The rule for automobile engines generally adopted is that the horsepower is equal to the square of the diameter of the bore, in inches, divided by 2.5, and multiplied by the number of cylinders. This is on the assumption of an average piston speed which has been found desirable for automobile engines, but gives a horsepower rather lower than most automobiles can develop at the present time.

James L. Miller has proposed the following:

Horsepower is equal to K [D × (D—1)] [R + 2] × No. cyl., where D is the diameter of the bore, in inches, and R is the ratio of the stroke to the bore. The constant K, for commercial and pleasure cars, is 0.197, and for racing cars, 0.33.

This formula, likewise the preceding one, does not take account of the speed of the engine, but assumes a fairly uniform piston speed.

A formula developed by experiment at Cornell University, for stationary gasoline engines, is as follows: Multiply the square of the diameter of the bore, in inches, by the length of the stroke, in inches, and by the revolutions per minute; divide the result by 16,400, and from the quotient subtract 0.5. This applies to single-acting, horizontal or vertical engines of the 4-cycle type, and gives the horsepower for one cylinder. A. L. R.

U. S. Coast Artillery Corps Examination Questions and Answers*

3 (a). When is the steam said to be saturated? When superheated?

A. Saturated steam is steam of the temperature due to its pressure.

Superheated steam is steam heated to a temperature above that due to its pressure.

3 (b). What is meant by "priming" in reference to a boiler?

A. Priming is the passing off of steam in belches which carry over water.

3 (c). The vacuum gage on the condenser of a steam engine indicates 27 in. What is the absolute pressure in pounds per square inch in the condenser with the barometer reading 30 in.?

A. At 62 deg. F., 1 lb. per sq. in. is equal to 2.0416 in. of mercury, so that 27 in. of mercury are equivalent to 27 divided by 2.0416, or 13.2 lb., while with a barometer reading of 30 in., the atmospheric pressure is equal to 30 divided by 2.0416, or 14.7 lb. The pressure in the condenser is then equal to 14.7 minus 13.2, or 1.5 lb. absolute.

3 (d). The pop valve of a boiler is set for 100 lb. If it fails to blow off when the steam gage indicates 110 lb., what would you do to ascertain the reason for its failure to blow off at 100 lb.?

A. Unless the steam gage is out of calibration, indicating 110 lb., when in reality the pressure is 100 lb., the first thing to do would be to get up on the boiler and operate the safety valve by hand. It may be that

*Continued from page 715, Sept. 1 issue.

it is stuck a trifle, due to some cause or other which may be readily remedied by doing this. Then again, this sticking may be due to the parts being corroded or scaled up, or it may be that some unauthorized person has been tampering with the valve. In any event, as long as the boiler remains in operation, exceedingly close attention should be paid to the pressure, seeing that this does not rise above that ordinarily carried. Then as soon as possible, the boiler should be cut out of service and when all pressure is off, the safety valve should be thoroughly examined and placed in proper working order. It may also be advisable to check the steam gage at this time.

4 (a). The low-pressure cylinder of a cross-compound engine is doing more work than the high-pressure cylinder. How would you correct this condition so as to divide the work evenly between the 2 cylinders?

A. In order more nearly to balance the load, it will, of course, be necessary to shift part of that being carried by the low-pressure side to the high-pressure cylinder. This may be done by advancing the point of cutoff of the low-pressure cylinder, which will reduce the receiver pressure and, in turn, the back pressure on the high-pressure cylinder, thus giving this side increased mean effective pressure with the result that a portion of the load is taken from the low-pressure side.

4 (b). As the difference in the temperature of the steam entering and leaving the cylinder of a steam engine is increased, what source of waste is generally increased, and how may this be at least partially avoided?

A. Cylinder condensation is the most prominent loss due to a marked degree of difference between the temperature of the steam entering the cylinder and of that leaving the cylinder.

This loss may be reduced by reducing the temperature range of the cylinder wall surface possible of accomplishment, first, by increasing the rotational speed of the engine; second, by supplying the engine with dry or superheated steam; third, by decreasing the ratio of expansion; fourth, by reducing the temperature range of the steam in the cylinder; and fifth, by jacketing the cylinder with steam of boiler pressure.

4 (c). What is the most accurate way of ascertaining the steam consumption per indicated horsepower of a steam engine, and how may the steam accounted for by the indicator be obtained from the indicator diagram? What is the value of such a determination?

A. A complete answer to this same question will be found published on page 170 of the Feb. 1, 1917, issue of Practical Engineer.

5 (a). The indicated horsepower of an engine is 563.74, and the net horsepower is 484.25. What is the mechanical efficiency?

A. The mechanical efficiency in this instance is equal to the product of 100 times the quotient obtained by dividing 484.25 by 563.74 or, 85.9 per cent.

5 (b). What is a balanced valve as used in a steam engine?

A. A balanced valve is one so constructed and arranged that the pressure of the steam is caused to act on all sides of it so as to reduce the losses due to friction of the working surfaces to a minimum.

5 (c). The valve of a plain slide-valve engine has ¾-in. outside lap and ¼-in. exhaust lap. Suppose the inside lap is reduced one-half on each end, what changes will take place in the events of the stroke?

A. Release will occur earlier and compression later.

5 (d). Into what 2 classes are engines divided with reference to the manner in which they are governed?

A. Engines may be governed by throttling or automatic cutoff governors.

6. Your engine is leaking around the piston rod and gives two distinct knocks at the wristpin at each revolution. It is suggested:

(a) That the crankpin may be out of line with the engine shaft.

(b) Wear and cutting in the main bearing, a poor job of babbiting, or a mistake in the adjustment may have thrown the engine shaft out of line.

(c) The piston and crosshead guides may not be parallel.

Describe carefully how you would test for each fault.

A. (a) The fact that the piston rod leaks at the stuffing box, might or might not be caused by any one of the three suggested causes. Most engines leak at the rods more or less—and the two knocks at the wristpin also could be caused by them, although frequently noises which seem to be at the wristpin have their cause at an entirely different place.

The possibility that the crankpin is out of line with the shaft is quite remote, as modern machine methods preclude errors in this line. In all the writer's experience, he has found but two instances where the crankpin was out of square. One was owing to the operator being careless in shimming up the crank disk when boring for the pin, and the other one was a 15 by 18-in. high-speed engine built by a reputable firm and which the writer was called upon to erect and later on, to remove and re-erect.

In the first instance, the crankpin after being pressed in, showed out of square about 0.025 in. in 8 in. (length of pin). The pin being turned at one setting was above suspicion and the hole was determined upon as the cause. The pin was pressed out again (not having been peened over yet) and saved for another job. The hole was checked up by a master square and a straightedge and proved to be defective. The crank disk was then put on a mill, accurately shimmed and clamped and a light cut taken out of the hole where the error in previous work was now apparent. A new pin turned to fit the newly bored hole made a first-class job.

In the second instance, the engine, being a direct connected unit, was presumed to have been tested at the shop of the builder and undoubtedly was, judging by evidence of wear at bearings, etc.; but when the engine was placed in service at about half load or over, it developed a decided knock at each center, and being enclosed and splash oiling, one could but look at the outside and conjecture. The guards were removed and the oil drained off, oiling for the time being was done lightly by hand. Under test, the knock showed up in the crosshead and on running slow with a strong reflector thrown at the interior of the crosshead from the crankpin and in line with the shaft, the rod was seen to weave back and forth on the crosshead pin, as there was considerable clearance.

The crankpin, on investigation, was found to be out of square, both by the application of the square and by the signs of wear. Being a small pin, about 4 by 5 in.,

a few good files, calipers and a steady eye eventually brought the pin out in fine shape. It was a small matter to scrape the boxes to fit, and the knock disappeared.

(b) Naturally the only way to learn anything about a main bearing is to dig down and see. Natural wear may take place more or less rapidly—depending upon speed, hours of service, quality of bearing metal and oil, and nature of surroundings, whether dusty, etc.

Some engines (comparatively few in number) have a split collar on the shaft on the eccentric side of the bearing, set into a slight indenture turned in the shaft, and which prevents lateral motion of the shaft. If this collar be removed, it exposes the ends of the bearing shells, when one can note the thickness of the babbit. One can then, also, see the construction of the bearing and decide on what methods are necessary to remove the shells. Sometimes, by loosening the eccentrics and sliding them along on the shaft, the bottom shell can be slipped out endwise by raising the shaft with a jack and supporting the disk on blocking; however, if the engine is a belted unit, brace the shaft well to prevent displacing by belt strain. If the shaft has a solid collar, the bearing shells must be removed in the ordinary manner. With the best engines, the lower shell is in two pieces, the inner one being turned concentric with the shaft, so that by raising the shaft 1/16 in., the shell can be rolled around the shaft and removed. You can now examine both shaft and bearing for cutting and note whether shells need re-babbiting. If there seems to be ample babbit metal in the shells, but the shaft is low in the main bearing, insert a shim under the lower shell, enough to raise the shaft the desired amount.

To test for a poor job of babbiting, requires a little experience and good judgment. One cannot tell by looking at babbit whether it is well suited for the work at hand or not. There are several hundred formulas for babbit metal for various purposes, and considerable fraud is practiced by the unscrupulous.

It not infrequently happens that the babbit will work loose from the shell with use, owing to poor anchorage, dirty, greasy or sandy castings, or both. To test for loose babbit, take a light ball peen hammer and tap lightly all over the babbited surface and where solid, the blow will be solid, but where the babbit is loose, it will sound like a cracked kettle under the blow.

For loose babbit there is no remedy but to re-pour. After removing old babbit, drill new anchor holes, quite large and projecting at various angles, so as to hold the babbit better.

There are more mistakes made in adjusting the bearings of an engine shaft than one suspects, and it does not take a monkeywrench engineer long to make wrong what a short time before was made right; and especially is this true if both bearings are adjustable, front and back.

The proper way to test for the shaft's being out of square with the engine, is to remove the reciprocating parts and stretch a line through cylinder and guides centrally. Then by calipering, or tramming from the line to opposite sides of the crank disk, any difference will suggest which way to move the shaft to bring it in line again. If time will not permit this, a good straightedge held against the back end of the cylinder and projecting in the same direction as the shaft and in the same plane, will provide a fairly accurate means of squaring up the shaft. Then with a steel tape laid on the edge of a board (to prevent sag), or even the edge of a good light board in place of the tape, measure from the shaft at the side of main bearing and also at the end, outside the outboard bearing, over to the straightedge, making accurate allowance for the difference in diameter of the shaft, if any. To obtain greater accuracy, lay off on the straightedge from the center of the cylinder, in feet and inches, the distance from the center of the crankpin box (center of engine) over to the points on the shaft from which measurements were taken. Move the shaft as required to obtain desired results.

(c) The cylinder and the crosshead guides being out of parallel or not is another matter that is quite prevalent and can be aggravated considerably by a monkeywrench. Few engineers take the pains when adjusting crosshead shoes to train and learn whether the rod is parallel to the sides or guides. Pistons, as a rule, naturally wear low in the cylinder; yet adjustments are generally made on the lower shoe to compensate for wear, thus tending to throw the rod much out of place. A rod in this condition will leak at the stuffing box in spite of all that can be done.

If bar or slipper guides are employed, the same care must be used in making adjustments, so as not to distort the rod from the true central position.

7. How would you set the valves of a duplex boiler feed pump?

A. With the piston and plunger in mid-stroke, the rocker arm operated by the rod joining these should be in a vertical position which may be determined by means of a plumb line suspended from the center of the rocker arm shaft. Then remove the cover of the steam chest and note the position of the valve operated by this side of the pump. If this is not central, make it so. Then repeat with the other side.

8. How would you make a complete inspection of a water-tube boiler?

A. Open the boiler and empty. Pass in through the upper manhole. Examine plates, flanges, seams and tubes; sound the braces, note location, thickness and consistency of scale, depth and extent of corrosion, location of oil and deposit, if any of these are present. See whether all openings to attachments are clear.

Next, enter lower manhole and examine plates, tubes, circular and head seams, and head flanges, sound braces, note opening to blowoff pipe and whether nipple is secured flush and sufficiently into flange.

In making the external examination of a boiler, pass in onto the grates, noting fire sheets, circular seams and side wall linings. Continue back of bridge wall and examine plates, rear head flange and tube ends. Note blowoff pipe, ell and flange on shell and whether pipe has free opening in rear wall. Note fusible plug, also condition of brick and combustion chamber walls and at and under rear arch. Pass out of setting door at rear.

Examine blowoff connections and valves, also lead to outside or catch basin. See if latter is well ventilated. Pass to top setting and examine all steam connections and adjustments. See that safety valve is free and that column pipe and steam gage connections are properly placed. Next open flue cap, examine front head and tube ends and head flange. Note water column and connections. Remove plugs in cross and see that pipes are clear, then test gage. In the course of inspection, the condition of the setting walls should also be noted.

Safe Working Pressures for Engine Cylinders

WHAT IS the formula for figuring the safe working pressure on an engine cylinder? READER.

A. The maximum steam pressure allowable on a steam engine cylinder may be found from either of the following formulas:

$$(1)\quad p = \frac{t - 0.4 \text{ in.}}{0.0002 \times D}$$

$$(2)\quad p = \frac{t - 0.375 \text{ in.}}{0.0003 \times D}$$

in which p = maximum pressure, gage; t = thickness of cylinder wall, in inches; D = diameter of cylinder in inches.

Formula (1) applies only to engines in which lightness is the prime consideration, and in which first-class material and workmanship are insured by careful inspection.

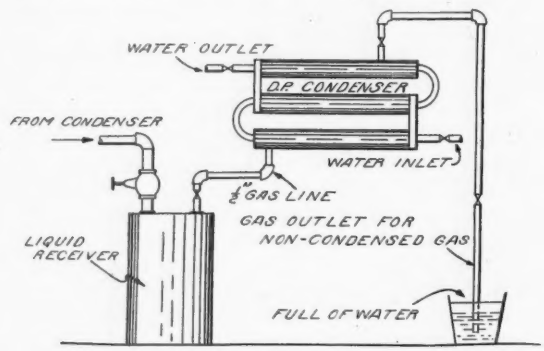
Formula (2) applies to cylinders above 10 in. in diameter, and is ordinarily employed for ordinary cylinders of slide valve engines. O. H. H.

Purging Ammonia Systems

WHAT IS the best method whereby an ammonia system may be purged of foul gas? G. W. D.

A. Noncondensible gas can be removed from the liquid receiver by the arrangement shown in the accompanying sketch, which can be used continually and will keep the system free.

If the receiver is fitted with a gas return line to the condenser, the connections are easily made; but in some few places, this return line has not been put in. In that case, the top head of the receiver is drilled and tapped for a ½-in. pipe. Put a ½-in. nipple in first, and then



ARRANGEMENT FOR REMOVAL OF AMMONIA

a globe valve. Next, either purchase or construct a double-pipe condenser, which need not be at all large; say, two or three pipes high and 6 ft. long. It is best to have this condenser standard size; that is, 1¼-in. pipe inside of 2-in. This condenser can be hung on brackets on the wall close to the receiver.

Pipe the ½-in. gas outlet from the receiver into the bottom connection of this condenser, and put a ½-in. valve at the top or outlet opening. Extend a ½-in. pipe from the outlet valve to the floor and have it end in a small tank or bucket which will be kept full of water.

The water connections for the inner tube should be made the same as on the regular double-pipe condenser; that is, inlet at the bottom and outlet at the top. There is not much condensing to be done, so little water is required.

While the plant is in continuous operation, the valve on top of the receiver is left wide open, and the valve at the top of the small condenser is cracked just enough to let the gas escape, in the form of bubbles, into the water in the pail.

If the system ever gets free from this objectionable gas, the gas extractor can be shut off and used again when deemed necessary. It will probably never be entirely shut off. W. P.

Internal Combustion Engine Questions and Answers

FOLLOWING is a set of questions and answers on the subject of internal combustion engines, recently submitted by Chas. Behounek, New York City.

Name one kind of fuel commonly used in internal combustion engines.

A. Gasoline vapor, which consists of a mixture of air and gasoline in given proportions.

2. Why is it essential to have all valves of a gasoline engine perfectly air and gas tight?

A. To make possible a universal mixture in all cylinders.

3. Does the ignition of the fuel occur inside or outside of the combustion chamber?

A. Inside of the combustion chamber.

4. What is necessary in order to have a gasoline engine develop full power?

A. Perfect compression, a proper mixture of gasoline and air and a good spark. The fit of the piston rings must be correct, the valves should be tight and the valve gearing must be in good working order.

5. In a 4-cycle engine, how many strokes does the piston make to each explosion?

A. Four strokes or 2 revolutions of the flywheel.

6. At what point of the stroke is the piston of a gasoline engine when the explosion occurs?

A. By adjusting a cam or other mechanism provided for the purpose operated by the valve-gear shaft for causing ignition, the time at which the ignition takes place, with reference to the end of the compression stroke, can be regulated. The mixture is usually ignited before the end of the stroke, the advance depending upon the inflammability of the mixture and the speed of the engine. A slow-burning mixture requires to be ignited earlier than a rapid-burning one, and a high-speed earlier than a slow-speed engine.

7. What course does the gas take after explosion?

A. It passes out through the exhaust port, through the exhaust manifold, through the muffler and out to the atmosphere.

8. What is the main mechanical difference in distribution of strains between those occurring in a vertical engine and those occurring in a horizontal engine?

A. In the vertical type, the several cylinders are placed alongside of each other and the strain in the crankshaft is all downward; while, in some horizontal

types of these machine, the cylinders are placed opposite one another, an arrangement dividing the strain to each side of the crankshaft.

Determining Size of Air Chamber

WILL YOU kindly inform me how to determine the size of air chambers used on reciprocating pump? S.

A. Relative to the subject of the size of air chambers required on reciprocating pumps, we find that, for ordinary boiler feed and service pumps, the volume of the air chamber is made two to three times the piston displacement of the pump, for a single-cylinder pump, and one to two times the piston displacement for a duplex.

Where a high piston speed is to be used, as in the case of fire pumps, the volume of the air chamber should be made six times the piston displacement.

The discharge air chamber should be mounted at the highest point of the valve chest, and above the delivery opening, in order to hold the air, and it must be provided with some means for renewing the air, as this will be readily absorbed by the water, particularly at pressures above 300 lb. per square inch.

While the air chamber is useful when applied to the discharge system, air pockets in the pump chambers must be avoided, in either suction or discharge end, as they will cause a churning back and forth without flow of water, due to the compression and expansion of the air in these pockets as the piston moves back and forth.

O. H. H.

Power-Factor Calculation; Flow of Steam Problem

HOW DO YOU find the power factor of a 3-phase alternating-current circuit?

2. How much heavy-body cylinder oil should a 16 by 36-in. Corliss engine running at 120 r.p.m. and using saturated steam at 100 lb. pressure, use in 12 hr.?

3. How do you figure the flow of steam through an orifice of, let us say, ¾ in.? Assume the steam pressure to be 100 lb. W. L. R.

ANSWERS

IN ALTERNATING-CURRENT work, the e.m.f. and current are seldom in phase, the current either lags or leads. The power factor, or ratio of volt-amperes to true watts, is the cosine of the angle of lag or lead of the current. Power factor is the relation of the actual load and the apparent load.

2. The subject of cylinder lubrication is open to extensive discussion and no fixed rate of feed will cover all engines. The writer heard of one 16 by 36 Corliss engine, running at 86 r.p.m. with 120 lb. steam, which was successfully operated with one drop for every 6 revolutions. Operating at 120 r.p.m. with 100 lb. steam, would, on the same basis, probably require about one drop for every 5 revolutions. Cylinder oil may contain from 4000 to 6000 drops per quart, thus it is difficult to estimate the 12-hr. consumption in liquid measure the following approxmiate fuel consumption per brake without knowing the viscosity of the oil.

To determine the proper rate of oil feeding, it is recommended that you cut down the supply until a slight tremor is noticed in the eccentric rods or, possibly, in a Corliss engine, a decided groaning is detected in one or more of the valves. If the oil is increased sufficiently to give the valves good operation again, after repeated trials, the engineer can determine how much of a particular brand of oil is required to keep the valves working smoothly and quietly.

The next thing in order would be to take out one of the valves and examine the wearing surfaces; if well lubricated it will present a dark, glossy appearance and enough oil to show on a piece of white paper when rubbed over the surface.

3. According to Swingle's handbook, steam of any pressure flowing through an opening into any other pressure, less than 3/5 of the initial pressure, has virtually a constant velocity, 888 ft. per second. Thus the amount discharged in pounds is proportional to the density of the steam.

To determine the pounds discharged per minute, multiply the area of the orifice opening in inches, by 370 times the weight per cubic foot of the steam.

Steam at 100 lb. gage pressure weighs 0.257 lb. per cu. ft., thus in this instance,

Weight of steam discharged in pounds per minute =

$$0.785 \times 0.75^2 \times 370 \times 0.257 = 41.9.$$

W. P.

Is the Indicator at Fault?

WITH REFERENCE to the diagrams of E. C. D., appearing on page 667 of the Aug. 15 issue, I would judge the engine in question to be operating with a misplaced eccentric and that in the attempt to obtain a proper admission line the radial rods were used in place of the eccentric, a common error in Corliss valve setting and one which always gives the same results—a late valve movement with an accompanying so-called freak diagram.

The hump shows that steam enters the cylinder after the valves are apparently tripped, due, no doubt, to the fact that the dashpots are slow in closing, possibly hanging up momentarily near the end of their travel. This does not show on Cards 1 and 3, which leads me to infer that the trouble is due to the dashpots and not to a leaky valve which would show the hump on all the diagrams.

The general setting of the valves is bad and due to no fault of engine design, valve motion or port opening, as is best evidenced by the well-nigh perfect steam line shown by diagrams 1 and 2, indicating that the valves and ports have ample area to supply all the steam required to maintain an approximately straight steam line on an overloaded engine at a very high piston speed and under the additional disadvantage of a late valve movement.

The piston speed of this engine (660 ft. per minute) requires not less than 60 per cent compression which will give better economic results and save considerable wear and tear on the bearings. It is due to lack of compression that this engine pounds. C. E. C.

TO REMOVE STAINS from marble switchboards take 2 parts of soda, one of pumice and one of finely powdered chalk. Sift through a fine sieve and mix into a paste with water. Rub this over the marble and the stain will be removed; wash the marble with soap and water and a bright polish will result.

POWER PLANT ENGINEERING

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Meeting the Fuel Situation

Power plant owners in this country have, up to the present time, been extremely fortunate in regard to the fuel available. In fact, so careless have many of them been that little thought has been given to the kind of coal they intend to burn in their furnaces when installing the plant, leaving the problem to the engineer to solve after he gets the plant into operation. It becomes his duty then to select from the available fuels that which best suits the furnace.

This getting the cart before the horse is no new situation but in the present national crisis it is indeed the exception to find a plant that is able to run along on the same grade of coal it did before coal deliveries fell off. At first the solution to the problem was to pay a higher price, hoping the situation would clear itself in a short time, but the drag became worse and everybody has had to accept almost anything he could get in the way of fuel; as a result very few furnaces are working under favorable conditions and continuous complaint seems to be the order of the day.

To meet the situation, engineers will be forced to do what, in many cases, should have been done years ago, i.e., redesign their furnaces to burn the cheaper grades of coal or other kinds of fuel available. While the expense necessary to make these changes may seem excessive to tide the plant over a temporary condition, in the end, we are thoroughly convinced, the results obtained will be so beneficial that the plant will continue to use the cheaper fuel with added economies after normal fuel conditions have been restored.

What is the most economical fuel to burn is a question that must be answered in each individual plant. The engineer who answers it wisely will consider the location of his plant geographically, transportation facilities, means for handling fuel, relative values of available fuels, considering always, what he can get out of them provided his furnace is of the design best suited to the fuel considered in each case; relative prices and their possible variation must be considered and then he is in position to make his selection and design his furnaces.

Such an investigation may prove that only the highest grade of steam coal should be used, but in the large majority of cases by a redesign of the furnace and grate or changing the type of stoker, a lower grade of coal can be used to good advantage. The possibilities of a furnace equipped to burn either coal or fuel oil, or coal or natural gas should not be overlooked. On another page of this issue, the results obtained by burning such low grade fuel as culm in pulverized form are given and readers will do well to give considerable time to the study of this comparatively new method of burning coal. Mixed grades of coal have advantages under some conditions; mine refuse and river coal (mine refuse reclaimed from river beds) are being burned successfully in properly designed furnaces; wood and leather factory refuse and even city garbage are profitably burned in furnaces of special design. Do not allow your factory to throw anything away until you have proved it of no commercial value as a fuel.

To meet the fuel situation successfully means above all else that combustion must be complete and boiler

efficiency high. An occasional CO_2 reading proves little; have your plant equipped with instruments that will guide the fireman continuously and give you a record by which to check up his work; set a standard for operation and see that it is lived up to. The coal situation is critical and the future existence of many small plants depends upon the engineers who are able to solve successfully the fuel problem.

Quiz Yourself

What instruments are needed in your boiler room to guide the fireman and show efficiency?

How would you support a B. & W. boiler so as to permit of expansion and contraction?

In replacing a boiler baffle, how would you determine the proper location for uniform gas velocity?

Make an estimate of the saving possible in your plant by the use of pulverized culm.

What changes are necessary in your furnace construction for burning powdered coal?

In ordering a centrifugal pump to feed your boilers, how many stages would you specify?

Would you recommend a pump governor for a turbine driven centrifugal boiler feed pump?

Have you made an effort to find out the unit costs of your plant? It will help you in determining when a unit should be discarded.

Can you make an electric heater for the scale house or detached room?

How much oil would you use in an ammonia compressor cylinder and where would you apply it?

Can you design a piping system for defrosting cooling coils without materially cutting down the capacity?

What draft should you carry in your furnace to secure smokeless combustion?

Why is your steam engine governor quicker in responding to speed changes than that on a water wheel?

Could a loose latch steel on a Corliss engine cause it to run away?

Have you failed to answer any of the above questions after reading this issue of Power Plant Engineering? If so, why?

A Hot Bath

By Charles Fenwick

HERE is the story of the dangerous result from a small neglect, just as I got it from the engineer of a flour mill in a small western town where I was waiting over between trains.

I had wandered into the engine room to see what might be found to interest during the waiting and began a chat with the chief, when his hands and arms, covered with scars, caught my attention. Naturally I was somewhat delicate about questioning him, but he noticed my curious glances and volunteered the explanation, as follows:

"It was back, let's see, about 8 yr. ago, up in Manitoba, I was running a little flour mill plant with a horizontal tubular boiler, an automatic slow speed engine, an open heater and the usual trimmin's, all pretty well bunched, as the main idea was to get the flour mill, and the power plant end, as usual in those small plants, was a kind of afterthought or incidental. So there was just room for a man to get through between the engine and heater.

"That heater, by the way, was some curiosity for that kind of apparatus. It was modeled after a boot, that is, there was a bottom part made large and of oval section, while the upper part was round and held the plates for the purifying and heating action. It was an old bird, and I don't know where it flew in from.

"Exhaust from the engine was piped direct to the heater, and the surplus from the heater was carried out by a pipe with a tee, one branch going to atmosphere with a back pressure valve, the other to the heating system of the mill.

"Well, the valve gear on that engine was driven by cams and on the head end exhaust the cam used to slip once in a while. I had several shut-downs from it which bothered us a little, but I never thought of it as a trouble that could prove serious. You can never tell, though, and I know better now.

"One morning, I started up as usual and had been running about 2 hr. when I noticed the oil was low in the cylinder lubricator and went in between the engine and heater to fill up. I was busy draining the water, when something behind me went off with a roar, and a great mass of boiling water wet me through from head to foot. The engine room was filled, seething, with steam and hot water, and I was struggling to get from between the engine and heater. The door was blocked by the explosion, and I managed to get as far as the window, but fell exhausted before I could open it.

"Next I knew, I found myself in a hospital, bundled up in bandages like a victim of the trenches. My hands, arms and legs had to be excused from duty while they grew a new crop of skin.

"I found out afterward, that, that dinky exhaust cam had slipped again and this time enough to hold the valve open so that live steam blew through the cylinder into the heater. The poor heater wasn't built for that kind of treatment and the back pressure valve couldn't take care of the steam fast enough, so the pressure built up until the heater shell let go, and as I was in the way, I got hit.

"The fireman tried to get in, but he found, as I had, that the door was blocked by pieces of the heater. Then he tried to get to the valve and shut off steam from the engine room main, but the wall between engine and boiler room did not go to the roof, and the steam came through so that he couldn't get up on top of the boiler.

"Finally he went outside, got a plank and smashed the engine room window and found me on the floor. Which is the reason I am now able to work, even if my arms are not well suited for wearing a sport shirt.

"Well, I learned one good lesson; it pays to look after the little things and make certain that everything, even though it may not seem important, is fixed right. Also that it pays to provide for emergencies before they happen so that safety first, last and all the time is insured."

And after I got home, I looked over my own plant with these lessons in mind and that experience of his to warn me; and there were several matters that had been neglected which got prompt attention, and some possible dangers that were removed and safeguarded.

On the Ohio

THIRTY-FIFTH ANNUAL CONVENTION OF THE N. A. S. E. AT EVANSVILLE, SEPT. 10 TO 15

FOURTEEN years ago, Evansville, Ind., was host to the National Association of Stationary Engineers and as delegates arrived, it was evident the host was anxious to renew old friendships and make new, for the welcome was extended not only by committees and city officials, but as if in fear of missing some lone engineer the bands played it and business houses and autos displayed signs of welcome not only in print but in the manner in which they greeted and served the delegates.

As a sort of curtain riser before the big show, the Indiana State Convention was held on Sunday and Monday. Think of getting a convention started at 9:20 Sunday morning! That is what the Indiana boys did and it is just an example of the energetic spirit with which the whole convention was carried out. Delegates to this convention were given an address of welcome by E. G. Heeger on behalf of Nos. 7 and 15, and as chairman of the National Convention Committee outlined the program for the big meeting.

In his brief address, President Lantz outlined the work of the State Association, urging the need of more subordinate associations so as to bring greater influence to bear upon legislators when a license law is up for enactment, recommending a joint state convention with Kentucky and suggesting several changes in the constitution.

In his report as state deputy, Mr. Heeger suggested that the National Association provide for a National Organizer who could visit a city and make a canvass of all engineers and explain the organization to them. It was thought many new associations could be organized that way and the older associations could be built up. He also spoke of the work of the employment bureau which was started by the association several years ago. Every manufacturer, he pointed out, should be advised that the association can furnish engineers for any plant in the state. In order to place engineers in the proper places, a card index showing experience and qualifications of members was suggested. By helping members get better positions and advancing young engineers into vacancies, a good work will be done which is bound to build up the organization.

National Vice-President John Wickert addressed the convention, giving suggestions for carrying on the work of state associations, calling attention to the value of visits to power plants and other associations and urging that men with business ability with the interests of the association at heart be chosen as delegates to conventions. Other welfare talks were made by Fred Raven, R. H. Holbrook, Joseph Meyer, Secretary Baldus and others.

Thus in two hours and a half the 15 delegates present were given, in concentrated form, suggestions and recommendations which, if worked out, will make a bigger state organization, better conditions for engineers and a safer state for the rest of humanity.

At Henderson, Ky., another state convention was assembled and the officers and delegates from Indiana spent the afternoon visiting in that city.

Monday morning, President Lantz called for the report of the various committees. The healthy condition of the association was shown by a balance in the treasury of $291.79. The ways and means committee recommended that an effort be made to combine the associations of Indiana, Kentucky and Tennessee so as to have a tri-state convention. The advantages claimed for such an arrangement were larger attendance, the meeting of delegates from adjoining states, less trouble and expense for the exhibitors which would thus result in better and more complete exhibits. A committee was appointed to meet similar committees from the other states concerned.

The following officers were elected to carry on the work for the coming year: President, Elza Stone, of Greentown; vice-president, Geo. Seng, Terre Haute; secretary, Wm. Bachley, Evansville; treasurer, Henry J. Peters, Indianapolis; conductor, Geo. Leuterbein, Evansville; and doorkeeper, Walter Kratz, Evansville. Geo. T. Smith, of Terre Haute, was recommended for state deputy.

GROUP AT THE N. A. S. E. CONVENTION

National Convention Begins

While the Indiana convention was in session, Chairman E. G. Heeger and his lieutenants of the National Convention Committee were having the last touches put to the plans for the reception and entertainment of convention crowds, and crowds they were, for all day Monday and Tuesday every train from every direction together with boats and autos brought its quota of delegates, visitors and supply men all interested in the welfare of the N. A. S. E.

Monday evening it started. In the Memorial Coliseum were 114 booths tastefully decorated to display to best advantage the products of manufacturers of power plant apparatus and many life sized pieces of machinery as well as models were on display. With several hundred in attendance, President John A. Kerley of the N. A. S. E. delivered an address of welcome, expressing the thanks of the engineers to the exhibitors for bringing their products to the convention under the distressing conditions in the world at large.

In response to this welcome, Harry D. Raymond, president of the National Exhibitors Association, declared: "We have brought to one of the best cities in the world one of the best exhibits staged at a convention." Words of praise for the exhibitors were spoken by Mr. Heeger and A. B. Bush, vice-president of the Evansville Manufacturers' Association, who spoke in behalf of the manufacturers of the city. With these addresses the exhibition hall was thrown open to visitors and was the principal attraction during the entire convention, though, of course, the efforts of the entertainment committee were not overlooked.

Following the opening of the exhibit, a reception and dance were tendered by the local engineers in Liederkranz Maennerchor Hall, just across the street, where the meetings of the convention were held.

The parade, headed by the chief marshal of the city and followed by deputies, a detail of police, autos filled with delegates, Mayor Bosse and the municipal band, led the way from the Vendome Hotel to the Coliseum Tuesday morning, and at 10 o'clock the formal opening of the convention took place.

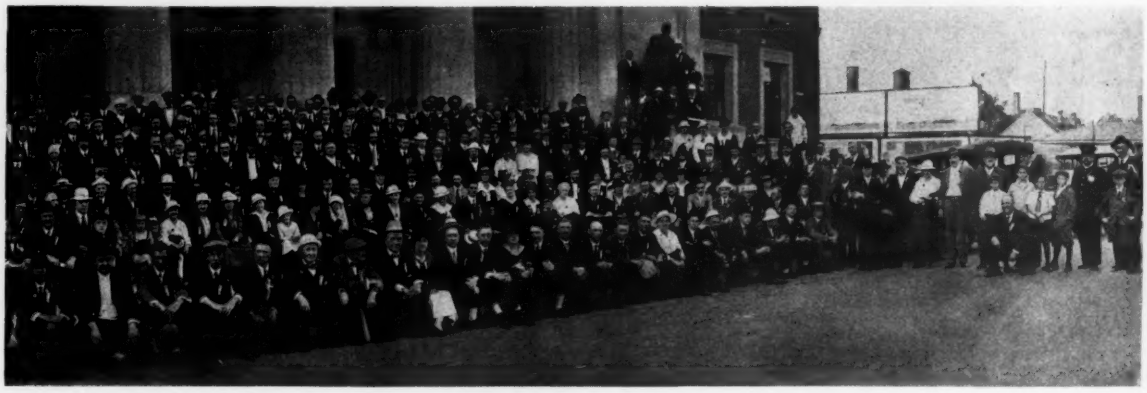
At the exercises, Mr. Heeger took charge, and after hearing patriotic music and amid the display of our national colors each speaker seemd instinctively compelled to pledge his support to the United States in its present crisis.

Owing to the serious illness of Governor Goodrich, Mayor Bosse extended a welcome to the engineers in behalf of both the state and the city. The mayor congratulated the engineers upon their organization, of which he himself is a member, assuring them that they had the hearty indorsement and good will of every manufacturer in the city in their endeavors. He declared that the Coliseum was an outgrowth of the spirit which the convention left in Evansville in 1903 and that the city was proud to be able to entertain them again.

President Kerley made a fitting response to the mayor, thanking him for the warm welcome, and told briefly of the important part taken in the world's activities by engineers, the educational work of the association and the noble work of the Ladies' Auxiliary.

Pleasant memories of the 1903 convention, said National Vice-President Wickert, made it easy to bring this convention to Evansville. He also called attention to the vastness of the power industries in this country and the prominence of the association members in all branches of the power field. The educational features of the mechanical exhibition and the necessity of a mutual understanding between those who make and those who operate were pointed out.

J. R. A. Hobson, secretary of the Evansville Chamber of Commerce, in a short address complimented the association on its growth since 1903 and then gave a boost for Evansville as a manufacturing city and the importance of engineers in its activities. Walter H. Damon, past national president, responded to Mr. Hobson, expressing the wish that all business men felt toward engineers as did Mr. Hobson.



GROUP AT THE N. A. S. E. CONVENTION

Kerley Takes Gavel

At the conclusion of these opening exercises, President Kerley assumed the chair and announced the appointment of his committees, after which adjournment was made until 2 o'clock, when the real business of the convention began with the report of the president, which showed an unusually active year with some disappointments but many successes. Among the recommendations offered were the following:

That a fund be created for the use of the license law committee, to be drawn upon only when every subordinate association in a state has pledged its support to the proposed bill.

That a system of education be undertaken that will

qualify members in tabulating and compiling data of power costs in their plant.

That open meetings be encouraged to which manufacturers and employers of engineers are invited.

That 15 per cent of the gross earnings of the association be set aside as a fund to be used exclusively for the relief of members or their families who are in distress as a direct result of the war.

In his report, the national deputy, John A. Wickert, regretted that the N. A. S. E. had made no material gain in numbers during the past year, for it was pointed out that the withdraws and suspensions had been greater than the initiations. This condition was attributed to several causes, but it was thought the greatest difficulties were due to the fact that many subordinate associations do not exercise proper care in the election of responsible and efficient men to office. One recommendation made was the provision for a permanent national organizer to be engaged to build up the membership of the association.

PRESIDENT JOHN A. WICKERT

The secretary, Fred Raven, showed in his report total receipts from all sources to the amount of $32,450.53; the membership is 21,287. S. B. Force, national treasurer, reported total receipts during the year of $40,331.97 and a balance on hand of $28,671.32 against $16,117.29 last year. Following these reports, Eugene Graham delivered a lecture on "How Manual Training Becomes Vocational Training," which concluded the business program for the day.

This was school day at the Coliseum and students of the engineering department of the manual training school visited the exposition in a body and studied the construction and operation of the various appliances which were explained by representatives in charge.

Again at 9:30 sharp, Wednesday morning, President Kerley was in the chair with his gavel and conducted what was more of a welfare meeting than anything else. There was, however, the report of the Credentials Committee showing the attendance of 309 delegates. Then C. W. Obert, secretary of the Uniform Boiler Law Society, addressed the convention on the advantages of uniform legislation throughout the country regarding boiler construction and advocated the adoption of the A. S. M. E. Code.

"The One Hundredth Anniversary of George Henry Corliss" was the title of a paper read by H. F. Mueller, of Minneapolis. It was an interesting though lengthy sketch of the great inventor's career showing step by step the progress and improvements he made throughout his active life which ended in 1888.

License legislation was the subject of the welfare talks, which started with a paper by John Lane. The experiences of various members on license law committees, the misunderstandings, the financial difficulties, the lack of cooperation, the opposition encountered, the political intrigues, and apparently all phases of the question from the standpoint of those who have succeeded as well as those who failed were given an airing which should at least put some life into those who desire license laws for their state.

Thus ended the business of the day, but nobody missed the field-day sports at Bosse Field, where the engineers ran over the supply men in a baseball game to the tune of 9 to 7, and again in a tug of war. It was a jolly crowd, however, and despite some defeats the supply men were among the leaders in the gayety on the trip to Cook's Park and during the barbecue which was served in the good old Kentucky style. Nearly everybody stayed in the park and enjoyed the amusements during the evening.

Thursday morning's meeting was marked with patriotic speeches as a specially appointed committee presented a telegram to be sent to President Wilson pledging the complete fidelity to the President and the country of the association's 20,000 members representing every state in the Union.

In the report of the Educational Committee it was stated that its activities had been confined in the main to the preparation and production of illustrated lecture material. This work had demanded a great amount of time; but the results obtained, it was thought, justified a continuation of the work.

Charles H. Bromley, at this session, read a paper on Increasing Attendance at Meetings. He believes it is an error to bar out of the association students under 21 yr. of age, as the questioning youth lends enthusiasm and arouses the interest of older men; also that at least 50 per cent of the association's expenditure should be for educational purposes. He proposed making out a list of subjects to be discussed during the year and the assignment of each to a member able to handle it; arranging for visits to power plants; teaching members power plant mathematics and other work which would compel attendance by its importance to the engineer.

Power Plant Records was the subject of a short talk by John F. Hurst in which he pointed out their necessity and the ease with which they could be kept.

For the afternoon, the entertainment committee had arranged for a boat ride down the Ohio to the Henderson bridge and not the slightest detail was omitted. The trip was made on the steam Joe Fowler with the barge Indiana in tow on one side and the barge Princess on the other. Music, dancing, refreshments and beautiful scenery each added its share to the enjoyment of the occasion.

At the Coliseum that evening the Exhibitors' Association gave its annual entertainment, which was principally musical numbers with an interposing of monologue work.

Election Day

All week there had been increasing enthusiasm shown in political circles, and when the meeting was called Friday morning, the reports of several committees were cut short and a talk by F. W. Fischer on record and data charts was given only briefly; the election of officers for the coming year was proceeded with and resulted as follows: President, John A. Wickert, of Milwaukee; vice-president, Roderick MacKay, of Los Angeles, Calif.; secretary, Fred W. Raven, of Chicago; treasurer, Samuel B. Force, of Pittsburgh; conductor, John F. Hurst, of Louisville, Ky.; doorkeeper, E. G. Heeger, of Evansville, Ind.; trustee for five years, Wm. J. Reynolds, Hoboken, N. J. Cincinnati, O., was chosen as the convention city for next year.

The work of the convention being over, nothing remained for the delegates to do but collect their mileage (at 5 c. per), which was the occupation of the afternoon,

PAUL T. PAYNE, PRESIDENT OF THE N. E. A.

install the officers and pay respect to society by attending the big ball that evening.

Thus ended the week full of enjoyable meetings of friends, old and new, receptions and dances, music and entertainments, arguments and debates, serious talks and eloquent lectures, and everybody confessed a tired feeling as they boarded trains for their homes that night and Saturday.

The National Exhibitors

Organized for the sole purpose of displaying and demonstrating their products to the engineers at their national convention, the National Exhibitors Association conducts only brief business sessions, the principal work of which is to elect officers for the coming year, which resulted as follows: President, Paul T. Payne, of Chicago; vice-president, Charles Cullen, of Cincinnati; treasurer, Horace Smith, of Philadelphia; executive committee, Charles Wilhoft, New York; Thomas Green, Pittsburgh; F. N. Chapman, St. Louis; L. W. Brooks, Jersey City; Frank Martin, New York City.

Credit is due to the outgoing president, Harry D. Raymond, and his corps of workers for bringing together such a large representation of manufacturers as exhibited in Evansville under present trying conditions. The exhibition hall being close to the hall where the business meetings of the N. A. S. E. were conducted, was an arrangement appreciated by all.

Below is given a list of the firms whose products occupied booths in the hall:

Allis-Chalmers Mfg. Co., Milwaukee, Wis.
V. D. Anderson Co., Cleveland, O.
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Arrow Boiler Compound Co., St. Louis, Mo.
Ackerman-Johnson Co., Evansville, Ind.
Birch-Hintz Mfg. Co., Chicago, Ill.
Black Diamond Mfg. Co., Cincinnati, O.
Bound Brook Engine & Mfg. Co., Bound Brook, N. J.
Babcock & Wilcox Co., New York, N. Y.
Bowers Rubber Works, San Francisco, Calif.
Builders' Iron Foundry, Providence, R. I.

CHARLES CULLEN, VICE-PRESIDENT OF THE N. E. A.

Chain-Belt Co., Milwaukee, Wis.
A. W. Chesterton Co., Boston, Mass.
Chapman Valve Mfg. Co., Indian Orchard, Mass.
Connelly Boiler Co., Cleveland, O.
Cling-Surface Co., Buffalo, N. Y.
Crandall Packing Co., Palmyra, N. Y.
Combustion Appliances Co., Chicago, Ill.
Crane Co., Chicago, Ill.
Crane Packing Co., Chicago, Ill.
Dearborn Chemical Co., Chicago, Ill.
M. H. Detrick Co., Chicago, Ill.
Jos. Dixon Crucible Co., Jersey City, N. J.
Durabla Mfg. Co., New York, N. Y.
De La Vergne Machine Co., New York, N. Y.
Esterline Co., Indianapolis, Ind.
Elliott Co., Pittsburgh, Pa.
Evansville Supply Co., Evansville, Ind.
Fisher Governor Co., Marshalltown, Ia.
France Packing Co., Tacony, Philadelphia, Pa.
Fairbanks Co., Chicago, Ill.
Garlock Packing Co., Palmyra, N. Y.
Greene, Tweed & Co., New York, N. Y.
Hawk-Eye Compound Co., Chicago, Ill.

Hills-McCanna Co., Chicago, Ill.
Home Rubber Co., Trenton, N. J.
International Trade Press, Inc., Chicago, Ill.
Jenkins Bros., New York, N. Y.
H. W. Johns-Manville Co., New York, N. Y.
Johns-Pratt Co., Hartford, Conn.
Keystone Lubricating Co., Philadelphia, Pa.
Laib Co., Louisville, Ky.
A. Leschen & Sons Rope Co., St. Louis, Mo.
Lunkenheimer Co., Cincinnati, O.
Martell Packings Co., Elyria, O.
H. P. Martin & Sons, Owensboro, Ky.
Mason Regulator Co., Boston, Mass.
Mueller Boiler Compound Co., Minneapolis, Minn.
McCord Mfg. Co., Detroit, Mich.
McLeod & Henry Co., Troy, N. Y.
Moore Oil Co., Cincinnati, O.
New York Belting & Packing Co., New York, N. Y.
Northern Equipment Co., Erie, Pa.
Otis Elevator Co., New York, N. Y.
Peerless Rubber Mfg. Co., New York, N. Y.
Philadelphia Bourse, Philadelphia, Pa.
Philadelphia Grease Mfg. Co., Philadelphia, Pa.
Perolin Co. of America, Chicago, Ill.
Wm. Powell Co., Cincinnati, O.
McGraw-Hill Publishing Co., New York, N. Y.
Quaker City Rubber Co., Philadelphia, Pa.
Richardson Phenix Co., Milwaukee, Wis.
Roto Co., Hartford, Conn.
S-C Regulator Co., Fostoria, O.
E. R. Senn Co., New York, N. Y.
Scully Steel & Iron Co., Chicago, Ill.
Southern Engineer, Atlanta, Ga.
C. E. Squires Co., Cleveland, O.
Smoke Consumers Co., Evansville, Ind.
Power Plant Engineering, Chicago, Ill.
Texas Co., New York, N. Y.
Turbo Rotary Engine Co., Evansville, Ind.
Vulcan Fuel Economy Co., Chicago, Ill.
Westinghouse Air Brake Co., E. Pittsburgh, Pa.

THE FUEL ADMINISTRATION has issued several pamphlets of value for reference purposes. These include the prices of bituminous coal, of anthracite coal, and jobbers' margins, fixed by President Wilson, and other data of interest concerning the Fuel Administration. These pamphlets may be obtained and your name placed on the mailing list for all future publications upon application to the Chief Clerk, U. S. Fuel Administration, 1023 Sixteenth Street N. W., Washington, D. C.

THE INDUSTRIAL COMMISSION of the State of Wisconsin has appointed a committee to formulate rules for safety appliances for refrigerating machinery. M. A. Edgar, State Boiler Inspector, Milwaukee, Wis.; John A. Wickert, chief engineer of the Joseph Schlitz Brewing Company, Milwaukee, Wis., and Theodore O. Vilter, Milwaukee, Wis., have been appointed on this committee. The committee has held one meeting, and at this meeting decided to recommend that the Industrial Commission await the promulgation of rules until the Refrigeration Regulations Committee of The American Society of Refrigerating Engineers had prepared its set of regulations.

Old Times and New

BY JOHN PIERCE

WE'RE reaching a point these latter days,
Where brains take the place of brawn;
Though we may laugh at the student's ways,
And were working ere he was born,
We must admit, if we are wise,
That time has brought a change;
We'll have to open our sleepy eyes
To see where our duties range.

We've clung to our old traditions
And thought old ways were best;
We've learned well to meet conditions,
Nor failed when put to test;
But in the days before us,
If we would wear a smile,
It's us to study that college cuss,
For he knows things well worth while.

'Twas sweet to feel that we were great
In the scoop and oil can times;
We could hold up pressure and keep joints tight
And heeded not the grime,
Though face and clothes were mostly black,
While we worked both day and night.
We've done our best to hold him back,
But the college chap can fight.

Today the plant is different,—
It's knowledge that gives us might,
The same as in days gone past us,
But our reasoning must be right.
The "muddling through" way, no longer
Will do in mechanical things.
The active mind that is trained to think,
Is greater than wealth of kings.

We must catch the shy heat unit
And force him to work our will;
We must fetter the madcap lightning
To its daily task in the mill.
Let's stretch out the hand of friendship
To the man of book and rule;
For our course in "Hard Knocks" College
Joins close with the "highbrow" school.

So, come on, friends and brothers,
There are happy days ahead;
Let us leave old times nor look behind;
The old-time ways are dead.
We have our bit of knowledge,
But progress comes thick and fast;
If we swap with the kid from the campus,
We shall get gain that will last.

Farewell to old traditions,
Crude methods must pass away;
Brute muscle and sweat and labor
Give ground when brain holds sway.
With scales and test tube and slide rule
Comes Science to lead our clan,
Fall in with the ranks of thinkers,
Join hands with the college man.

News Notes

On Sept. 1, Warren Webster & Co.'s Detroit Branch Office moved from 2131 Dime Bank Building to new and enlarged offices at 2123 Dime Bank Building, Detroit, Mich.

Old time "conventioners" were pleased to count David J. Fleming as among those present. He was a delegate from San Francisco, Cal., and between "delegating" and boosting for Skookum packing, was a very busy man.

The American Engine and Electric Co., of Bound Brook, N. J., has been taken over by the Bound Brook Engine & Manufacturing Co., also of Bound Brook, who will continue the manufacture of the American Ball engine. Harry J. Marks, 111 Broadway, New York City, is district sales manager of the latter company.

The Crane Packing Co., Chicago, manufacturer of "John Crane" flexible metallic packing for all vapors and liquids, announces the establishment of its Eastern office in the Woolworth Building, New York City. Their engineer, A. W. Payne, with much experience with packing problems in the oil, mining and industrial fields, has been placed in charge of this branch.

The Lamprey Co., Westfield, Mass., has recently been incorporated. The officers of the company are: George A. French, president; J. B. Atwater, vice-president; E. L. Lamprey, treasurer. Mr. French is also the factory manager. The company has added Mark Aborn and G. A. Troop to its sales force, in order to cover the New England territory more thoroughly.

A printed statement of Information for Bidders on the $25,000,000 flood prevention project at Dayton, Ohio, on which it is expected to let contracts for $10,000,000 worth of work on Nov. 15, 1917, has just been published. Among the list of proposed contracts are noted equipment for a sewage pumping station and a water and electric light station. This work is being undertaken by the Miami Conservancy District, Dayton, Ohio.

The Board of Directors of the American Association of Engineers, at their meeting on Sept. 5 granted charters to the members in St. Paul, Indianapolis and Milwaukee. This makes a total of seven chapters which have been organized since the association was incorporated about 2 yr. ago. The total enrollment of the national organization is over 2200 different members.

A joint meeting of the association and the Detroit Engineering Society was held in the Commerce Building Thursday, Aug. 30. It was the unanimous opinion of the engineers present that the Detroit society should form a working co-operation with the American association, as they have been carrying out a similar program locally for Detroit as the other organization has operated in a national way. The Detroit society has a total enrollment of about 700 members and if this working co-operation is established it will mean the furthering of the work laid out by the committee on engineering co-operation.

Membership in the American Association of Engineers is being extended to all technical engineers in military service without payment of initiation fee or dues. This is part of the co-operative plan to keep them advised as to progress in the engineering field and to give them personal assistance upon their return to their professional work.

Freling Foster, until recently advertising manager, Hughes Electric Heating Co., Chicago, has joined the advertising staff of The Society for Electrical Development. He will take the place made vacant by the resignation of E. M. Hunt, who has become connected with the "Review of Reviews."

Jack H. Frohlich is another new member of the Society's publicity staff under Harry W. Alexander, Director of Publicity. Mr. Frohlich has been with the Frank Seaman Advertising Agency, New York, and before that was publicity agent for The Vitagraph Co. of America.

The Society has now completed its reorganization due to several army enlistments. Hill Griffith, until recently with the advertising department, has been made Captain of Cavalry at Fort Meade, Md. R. R. Jones is now First Lieutenant in the Signal Service. J. J. Flynn is with the National Army at Camp Upton, Long Island.

Catalog Notes

COMPARATIVE FIRE RESISTANCE of Roofing Material is the subject of an interesting booklet just issued by the West Coast Lumbermen's Association, showing the results of recent experiments conducted at the University of Washington in which blazing brands were applied to shingles and various kinds of so-called "fire-resisting" patent roofing. The tests were highly favorable to the shingles, the fire-resisting qualities of which are, according to Bror. L. Grondal, assistant professor of forestry at the University, who conducted the experiments, "greater than any of the 'patent' roofings included in the test."

CONDIT ELECTRICAL MFG. Co., of South Boston, Mass., is issuing new bulletins covering its electrical protective devices, as follows: Bulletin Nos. 413 and 414, on oil switches and circuit breakers; No. 415, on transformers; No. 416, on induction and synchronous motor panels; and 417-1, on series overload relays for use with alternating-current motor starting devices. These bulletins are in the hands of the company's district representatives, who will be pleased to forward copies to anyone upon request.

THE GENERAL ELECTRIC CO. recently issued a 32-page bulletin, No. 48,900, containing some interesting data on CR-9510 Automatic Solenoid Brakes and CR-9500 Solenoids. There has been, for some time, a growing demand for a line of alternating-current and direct-current solenoid brakes possessing not only all the characteristics which present day operating conditions have proven desirable, but also automatic or self-adjusting features. The General Electric Co. has developed such a line of brakes for motors of one horsepower and larger. Solenoid brakes are used for the more or less quick stop-

ping of rotating parts. When the power is cut off, the brake sets and applies a retarding force to the shaft, through friction between the brake shoes and wheel, which brings the shaft and driven parts to rest. Each size is built as a self-contained unit and is usually mounted on the driving shaft or bolted to the floor.

This bulletin may be secured from the nearest General Electric sales office.

A NEW FOLDER from Carrier Air Conditioning Co., Buffalo, N. Y., is so made that it shows the construction, both inside and outside, of the Carrier Air Washer.

FROM LINK-BELT CO., 39th St. and Stewart Ave., Chicago, we have just received Book No. 342 entitled, "Casings for Link-Belt Silent Chain Drives," and Book No. 246 on Link-Belt Electric Hoists.

THE GENERAL ELECTRIC CO. has just issued Bulletin 48,319-A, describing in detail CR-1340 and CR-1342 pressure-controlled, speed-regulating panels with automatic pressure regulator. These equipments are designed for use with motor-operated feed-water pumps for boilers, gas blowers, mechanical stokers, blowers, etc. An automatic pressure regulator provides the most convenient means of controlling the speed of a motor operating an equipment, where changes in air or liquid pressure will automatically vary the speed, in order to maintain the pressure within certain limits. If the pressure runs above or drops below that for which the regulator is adjusted, the motor is automatically retarded or speeded up until the pressure is again constant. The CR-1340 type provides manual starting and automatic speed regulation by field control. The CR-1342 type provides 50 per cent speed reduction by armature control and 25 per cent speed increase by field control. Wiring diagrams, dimensions, as well as the operation of CR-1340 and CR-1342 pressure-controlled, speed-regulating panels with automatic pressure regulator will be found in this bulletin.

Trade Notes

THE BURT MFG. CO., Akron, O., has received a rush order for 125 of its 24-in. Burt ventilators and bases to provide an abundance of fresh air when the Sammies are not on the firing line. They have also just shipped 50 ventilators for use at Camp Ft. Benjamin Harrison at Indianapolis, Ind., and the balloon house and officers' quarters at the Aviation Camp at Fritsch's Lake near Akron are also equipped with Burt ventilators. An order for a dozen large oil filters for use on warships has also been received.

AS PART OF ITS PLANS for providing facilities for its rapidly increasing load, the Consolidated Gas & Electric Co., of Baltimore, has ordered two 22,000-kv.a. turbo-generators, operating at 13,200 v., 3-phase, 25 cycles. These, together with two 32,000 sq. ft. condensers, are to be furnished by the Westinghouse Electric & Mfg. Co., of East Pittsburgh, Pa. To furnish additional power to industrial plants in the vicinity of Westport, Md., the same company has purchased four 12,000-kv.a. and one 1750-kv.a. Westinghouse transformers, all rated 13,200 to 2640 v. 3-phase, 25 cycles.

POWER PLANT ENGINEERING

Trade-mark, Reg. U. S. Pat. Off.

SEMI-MONTHLY

PUBLISHED ON THE FIRST AND FIFTEENTH OF EACH MONTH

Subscription price in advance in the United States, Mexico or united possessions, $1.00 a year.

In Canada, subscription price, $1.75 a year.

Foreign Countries, subscription price, $2.50 a year.

Address all letters and make all checks and money orders payable to Technical Publishing Co., 537 S. Dearborn St., Chicago, Ill.

Any advertiser is invited to examine our paid subscription lists and Post Office mailing receipts at any time.

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Full page, one year, each insertion, $66.00.

Half page, one year, each insertion, $38.50.

Quarter page, one year, each insertion, $22.00.

Eighth page, one year, each insertion, $13.25.

Front cover, $175.00 per issue.

Other specified positions, regular rate plus 10 to 50 per cent.

Stippled plates used, but no heavy, black and white plates.

Classified Rates

Per line, 30 cents each insertion.

Advertisements in this section are inserted under regular headings.

No display type allowed, but the first three words may be set in capital letters.

About nine words make a line. Minimum space sold, two lines.

Under classification "Position Wanted," advertisements not exceeding four lines will be inserted once for subscribers free of charge.

All copy should be received at Chicago office 18 days before date of publication.

Circulation of this issue, 22,000.

Technical Publishing Co.

537 S. Dearborn Street

Chicago

Position Wanted

POSITION WANTED—By engineer; have Ohio engineers' and boiler inspectors' licenses. Experienced with absorption method of manufacturing gasoline. Good references. Address Box 481, Power Plant Engineering, 537 S. Dearborn St., Chicago, Ill. 9-1-3

POSITION WANTED—By young man as oiler in large central station, with 7 years experience with Corliss engines up to 400 hp., d.c. generator. I. C. S. graduate on complete Steam Engineering. Age 27. Married. Best of reference. Will go any place. Address Box 490, Power Plant Engineering, 537 S. Dearborn St., Chicago. 10-1-1

POSITION WANTED—As helper or oiler in small or large plant. Will come at once. Sober and industrious. Will consider reasonable salary. Address Box 491, Power Plant Engineering, 537 S. Dearborn St., Chicago, Ill. 10-1-1

POSITION WANTED—By young man as oiler or assistant engineer in or around Chicago, with chance of advancement. Eight years' experience; ready to start work at a week's notice; references. Address Box 492, Power Plant Engineering, 537 S. Dearborn St., Chicago, Ill. 10-1-1

POSITION WANTED—Chief Engineer or Master Mechanic of Light & Power Co., or Factory; 12 years' experience. Age 30. Married. Present salary $1,500. Good references. East and middle west preferred. Address Kurt Illig, P. O. Box 77, Tuxedo, N. Y. 9-1-3

POSITION WANTED—As engineer in small steam plant not over 125 hp., by young man. Steady and sober habits. More than 5 years' experience as engineer in grain elevator. Good mechanic. Address Box 123, Dixon, Ia. 8-1-5

POSITION WANTED—By steamfitter with 17 years' experience at the trade. Can furnish references as to habits and ability to handle men. I am 33 years old. Married. Address J. H. D., 669 Wunderlick St., Barberton, O. 9-1-3

POSITION WANTED—By thoroughly competent man with 11 years' experience as engineer and assistant superintendent in sugar factories in Cuba, Mexico and Louisiana. Good steamfitter and machine repairman. Have had charge of 10 steam boilers and 6 ammonia compressors as day and night engineer. Can speak English, Spanish and some German. Single. 26 years old. Can furnish good references. Address Box 480, Power Plant Engineering, 537 S. Dearborn St., Chicago, Ill. 10-1-1

POSITION WANTED—By young man, 23 years old, as fireman or oiler in ice or electric light plant in city of St. Louis. Have had one year's experience in firing and some experience in steam engineering. Address Leonard Ochs, 1536 Papin St., St. Louis, Mo. 9-1-3

POSITION WANTED—Young man wishes a position as oiler or assistant to the engineer in a plant in New York City. One year practical experience. Address A. Benora, 38 Park Hill, Yonkers, N. Y. 9-1-3

POSITION WANTED—By young man as assistant engineer or assistant switchboard operator in plant in or near Newark, N. J., where there is a chance for advancement. Three years' practical experience. Address Wm. Wykes, 358 S. 7th St., Newark, N. J. 10-1-1

POSITION WANTED—By practical engineer of 15 years' experience. Am familiar with a.c. and d.c. generators and motors, also refrigerating machinery. Am 38 years old, married, and strictly sober. Good references. E. W. Jones, Genl. Del., Metropolis, Ill. 9-15-2

POSITION WANTED—Will represent some engineering firm in Mexico or take a position as chief engineer. Can operate electric, ice or power plant. Can speak, read and write Spanish. Am practical and progressive engineer. Will consider only well rated concern. Am colored. C. D. Bassett, Engineer, 183 N. Wabash Ave., Chicago, Ill. 9-15-2

POSITION WANTED—By young man as engineer in power plant. Seven years' experience in gas works and small central station operating. A-1 references. Present salary $1,300. Married. Age 25. Address Box 490, Power Plant Engineering, 537 S. Dearborn St., Chicago, Ill. 9-15-2

Help Wanted

WANTED—Resident subscription agents in the following cities: Atlanta, Ga.; Cincinnati and Columbus, Ohio; Kansas City, Mo.; Los Angeles, Cal.; Louisville, Ky.; Newark, N. J.; New Orleans, La.; Portland, Ore.; St. Louis, Mo.; San Francisco, Cal.; Washington, D. C. This is an excellent chance for a hustler, who is familiar with power plant conditions, to turn his spare time into dollars. To such a one we offer a Real Opportunity. Write Subscription Department, Power Plant Engineering, 537 S. Dearborn St., Chicago, Ill. tf.

Wanted

WANTED—Agents on commission to sell our shaking grates. We will install grates on trial or put it to test at our expense with any grate made. Address Armstrong Mfg. Co., Springfield, Ohio. tf.

WANTED—Agents handling engine and boiler room specialties in every section for side line paying large commissions. Give experience, line carried and territory covered. Box 381, Power Plant Engineering, 537 S. Dearborn St., Chicago, Ill.

WANTED—Marine boilers. We will pay cash awards for information that leads to a purchase by us of marine boilers of from 75 hp. to 250 hp. The Pittsburg Boiler & Machine Co., Pittsburg, Kan. tf

For Sale

FOR SALE—Edon (Ohio) Furniture Company plant for sale. Full equipment for manufacturing all kinds of woodwork. Saw mill and only feed mill of the town in connection. First class shipping facilities. Good town. Great bargain. Owner deceased. J. H. Schrider, Bryan, Ohio. 10-1-2

FOR SALE—Slater Corliss engine, 150 hp., used two years; National feed water heater; Knowles double acting boiler feed pump, 3¼x3½x5; Stewart horizontal tubular boiler, 150 hp., 125 lbs. pressure; 24-in. single drum steam hoist with 300 ft. of ½-in. steel cable; Blake duplex steam pump, 4¼x4¾x5; B. F. Sturtevant engine connected 60-in. boiler with steam coils. S. Seiger, 22 Portland Pier, Portland, Me. 9-15-2

FOR SALE—250-volt, direct-connected units. 100-kw. G.E. with Ridgway engine, $2200; 75-kw. G.E., 3-wire, with Buckeye engine, $2000; 50-kw. Allis with Harrisburg, $1200; 30-kw. G.E. with Harrisburg, $900. Power Machinery Exchange, Jersey City, N. J.

Patent and Patent Attorneys

PATENTS THAT PROTECT AND PAY—Advice and books free. High references. Best results. Promptness assured. Send sketch or model for search. WATSON E. COLEMAN, Patent Lawyer, 624 F St., N. W., Washington, D. C. tf.

PATENTS—C. L. Parker, Attorney-at-Law and Solicitor of Patents. Patents secured promptly and with special regard to the legal protection of the invention. Handbook for inventors sent upon request. Washington, D. C. tf.

PATENTS—H. W. T. Jenner, Patent Attorney and Mechanical Expert, 606 F St., Washington, D. C. Established 1883. I make a free examination and report if a patent can be had and the exact costs. Send for full information. tf.

A. P. CONNOR, Consulting Electrical and Mechanical Engineer, Attorney-at-Law and Solicitor of Patents and Trade-Marks. Results guaranteed. 121 Carroll St., S. E., Washington, D. C. tf.

PATENTS—Send sketch for free search and reports. Books on patents and book of reference letters sent free. John S. Duffie & Co., 612 F St., Washington, D. C. tf.

PATENTABLE IDEAS WANTED—Send for three free books. R. B. Owen, 28 Owen Bldg., Washington, D. C. tf.

Technical Books

FREE ENGINEER BOOKS and power plant tools and specialties, for securing new subscribers for Power Plant Engineering. A dandy chance for the engineer with a little spare time to get some fine premiums. Send for free descriptive circular and terms. Subscription Department, Power Plant Engineering, 537 S. Dearborn St., Chicago, Ill.

Miscellaneous

ENGINEERS, DO YOU WANT to utilize your exhaust steam for heating or drying purposes with back pressure on your engine? If so, address Monash Engineering Co., 1413 Jackson Blvd., Chicago, Ill. tf.

Sparks From The Advertising Pages

Buying Made Safe and Easy

Does the average person ever stop to think what a safe and easy thing buying has become in our day—What a contrast to the way it used to be within the memory of most of us?

This applies to all buying—of necessities, of luxuries, of everything.

Mr. John Sullivan, Secretary of the Association of National Advertisers, in a recent interview said some things on this subject which should interest every buyer in the world. For his words apply to the purchase of anything, from a 5 cent cake of soap up to the most expensive advertised article.

"Today," said Mr. Sullivan, "the housewife sends her little child to make purchases at the corner grocery. She sends her with perfect confidence that, even though a child, she cannot err therein. All that the child needs is explicit instructions to buy THIS or THAT. In the case of all staple produce the price is known, the quality is known and the Name is known. There is practically nothing about the goods that is unknown. And to be sure of getting exactly what you want, it is only necessary to name the goods.

"It is the same in other stores of nearly every kind.

"What a contrast to the days of our fathers, when practically all buying was a hazard—impossible for the child and risky even for the parents!

"In those so-called 'good old days,' soap was just soap, prunes were just prunes, coffee was coffee—and so on through the long list of things that are used in every home.

"In no case was there any guarantee of quality—or any sure way to identify goods that might have proved satisfactory so that the same goods could be bought again. The whole buying game was just a game—a game and a gamble; with all the odds against the buyer.

"Then gradually, step by step, came the great change. The TRADEMARK began to appear—a positive means of identifying goods. and with the trademark came ADVERTISING on a national scale—the best, the surest, the cheapest, the only efficient way of making the merits of these goods known to buyers everywhere.

"Trademarked merchandise was soon found to be good merchandise—worthy of every buyer's confidence.

"In fact, trademarked articles have got to be good. The trademark identifies them, advertising proclaims them, and use by thousands and millions make their qualities positively known. Only first class merchandise can dare to court such a test. A well-known trademark is an asset of priceless value for a good article, but it would be sure death for a poor one, for in that case it would not be a guarantee but a WARNING TO THE BUYER. It would help him to identify the bad as well as the good; to avoid the one and choose the other.

"The greatest achievement of modern advertising is that it protects the buyer; it makes buying both easy and safe. The value of every trademark depends on the good will of the buyer, therefore this trademark, which positively identifies the goods, for better or for worse, is the buyer's sure and certain guarantee."